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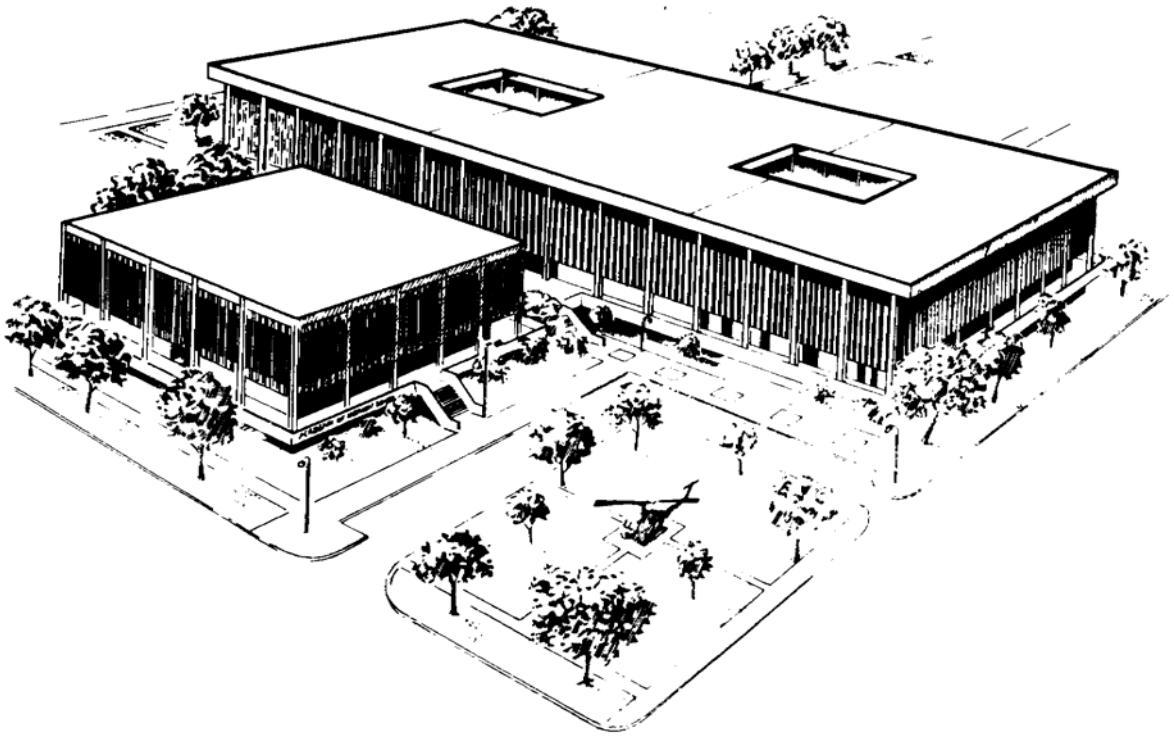

RODENT BIOLOGY, SURVEY, AND CONTROL

SUBCOURSE MD0172 EDITION 100

DEVELOPMENT

This subcourse is approved for resident and correspondence course instruction. It reflects the current thought of the Academy of Health Sciences and conforms to printed Department of the Army doctrine as closely as currently possible. Development and progress render such doctrine continuously subject to change.

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CLARIFICATION OF TRAINING LITERATURE TERMINOLOGY

When used in this publication, words such as "he," "him," "his," and "men" are intended to include both the masculine and feminine genders, unless specifically stated otherwise or when obvious in context.
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SUBCOURSE MD0172

RODENT BIOLOGY, SURVEY, AND CONTROL

INTRODUCTION

Modern man may never know when rats and mice first left the fields to establish their homes in and near the primitive dwellings of early man. The history of the rat in the last few thousand years is well told; for when man first recorded for posterity the events of importance to himself, he began the written history of the rat. We know today, that from that time on, man has never without his unwelcome associate. The rat has followed the soldier to the battlefield to establish himself as the enemy. It has gone before the reaper to the fields at harvest time and come along to the granaries. It has followed the butcher to the slaughterhouse and helped dispose of refuse. It has sailed with the explorer on his voyages of discovery and has helped to settle new lands. It has lived before us in our new homes and remained when we departed. It has been our companion in times of plenty, as in times of famine, epidemic, and disease. As we have shared with it our food, our homes, our health, and even our lives, it has shared with us its filth and destruction, its mites and fleas, and its ravaging diseases. The three murine, or domestic rodents are the Norway rat, the roof rat (with various subspecies), and the house mouse.

In order that we be prepared to handle rodent problems, we must first know something of the rodent's biology. It is the objective of this subcourse to provide the knowledge necessary to identify the murine rodents of military importance, survey to determine the degree of infestation, and control the rodent population in a given area.

Subcourse Components:

This subcourse consists of three lessons. The lessons are:

Lesson 1, Rodent Biology.

Lesson 2, Rodent Survey Procedures.

Lesson 3, Rodent Control.

Credit Awarded:

To receive credit hours, you must be officially enrolled and complete an examination furnished by the Nonresident Instruction Section at Fort Sam Houston, Texas. Upon successful completion of the examination for this subcourse, you will be awarded 5 credit hours.

You can enroll by going to the web site http://atrrs.army.mil and enrolling under "Self Development" (School Code 555).

A listing of correspondence courses and subcourses available through the Nonresident Instruction Section is found in Chapter 4 of DA Pamphlet 350-59, Army Correspondence Course Program Catalog. The DA PAM is available at the following website: http://www.usapa.army.mil/pdffiles/p350-59.pdf.

LESSON ASSIGNMENT

LESSON 1	Rodent Biology.
LESSON ASSIGNMENT	Paragraphs 1-1 through 1-12.
LESSON OBJECTIVES	After completing this lesson, you should be able to:

1-1. Identify the physical and behavioral characteristics of the three domestic rodents.

1-2. Identify the specific habitats and foods preferences of the three domestic rodents.

1-3. Identify diseases for which rodents are reservoirs and the means of transmission for each disease.

SUGGESTION After completing the assignment, complete the exercises of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 1

RODENT BIOLOGY

Section I. INTRODUCTION TO RODENTS

1-1. GENERAL

a. Man has been combating rats and mice across much of the earth for hundreds of years. His control efforts have taken numerous forms, and many have been the attempts to "build a better mousetrap." Building a better mousetrap, however, requires that one first know something about the mouse. It is no surprise that man's most successful methods for controlling rodents are based on knowledge of the rodents themselves. The knowledge of the biology and habits of rats and mice is an important weapon to use in their control.

b. In North America, the rodents include such native animals as the squirrels, woodchucks, field and wood mice, pack rats, gophers, porcupines, and the beavers. They also include three imported species. The Norway rat (Rattus norvegicus), the roof rat (Rattus rattus), and the house mouse (Mus musculus). These last three belong to the Old World War family “Muridae”, and are often called commensal or domestic rodents, due to their close association with man (see figure 1-1).

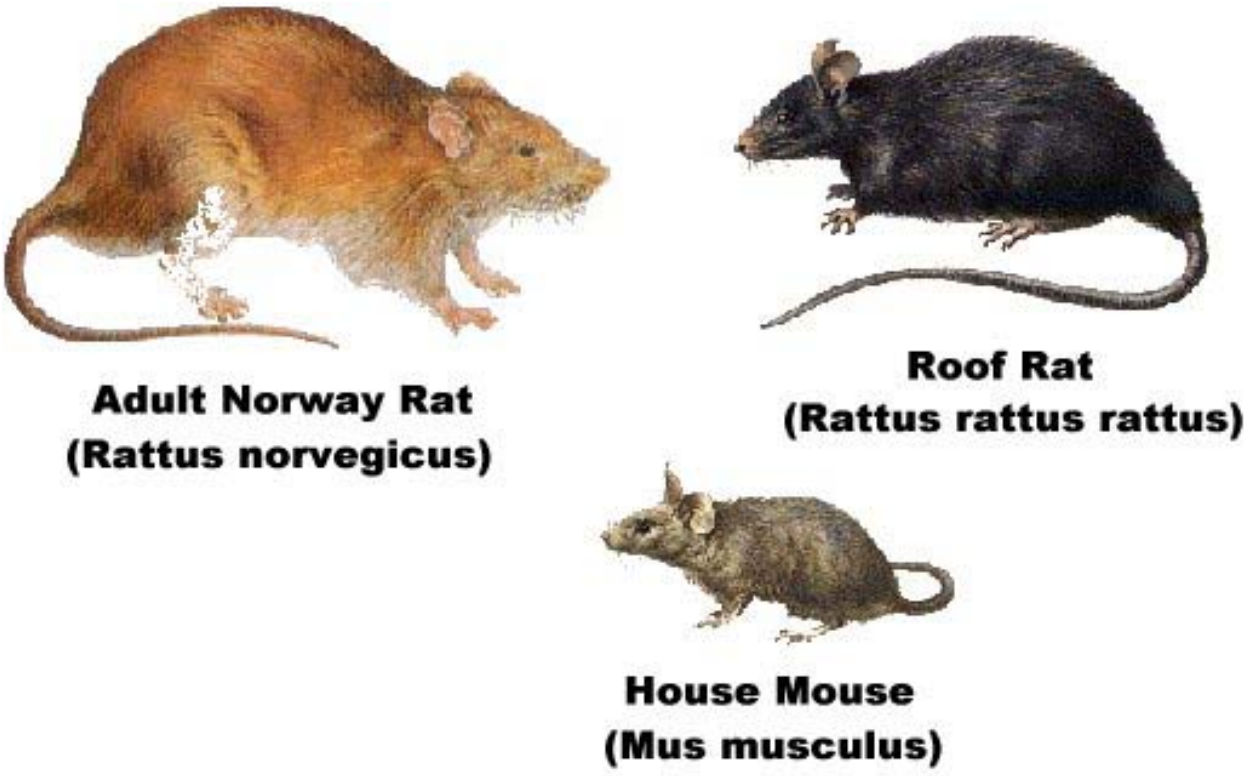


Figure 1-1. Rodents of military importance.

1-2. IMPORTANCE TO MAN

a. Many of the native North American rodents are of considerable economic importance to man--some for their pelts and others because of the damage they cause. However, the three imported, commensal rodents are far more destructive to man and his property than are the native rodents. One or more of these three are found almost everywhere that man dwells.

b. The Armed Forces are concerned with rodents primarily because these animals act as reservoirs of some of the most serious diseases affecting man. Nevertheless, the economic aspects of a rodent population are also of considerable significance. The monetary losses encountered through consumption and contamination of foodstuff and through damage to buildings and property amount to millions of dollars annually.

c. Many other rodents are of military importance. Noteworthy of these are the Polynesian Rat (Rattus exulans) found from Southeast Asia to New Zealand and Hawaii and the lesser bandicoot (Bandicota bengalensis) found throughout Southern Asia.

1-3. MEDICAL IMPORTANCE--RODENT-BORNE DISEASES OF PRIME IMPORTANCE

a. **Plague.** Plague ranks first in importance among rodent-borne diseases. Essentially a disease of rats and other wild rodents, this bacterial disease may be transmitted to man by a flea, which previously has fed on an infected rodent. The bacteria (Yersinia pestis) enters the human body when the flea attempts to feed. Cases originating in this way are termed bubonic plague. Cases or even epidemics of pneumonic plague may develop from a bubonic case by means of the respiratory discharges of the victim and without any relationship to rodents. The explosive epidemics of plague are of the pneumonic type. This was the historic "Black Death" which killed millions of people in Europe, Asia, and Africa, following the sweep across Europe and into commerce of an exploding population of rats. No serious outbreaks of human plague have occurred in the United States (US) recently; however, sporadic cases of sylvatic plague (coming from the reservoir of wild rodents) do occur. This reservoir of plague exists without contact with domestic rodents, and with man entering the cycle only occasionally. However, the danger is always present that wild rodent fleas will infect domestic vertebrate hosts, and thence that the fleas from these will infect man with the plague bacteria. The disease is usually fatal to the fleas and the rodent, as it is to man when treatment is delayed. Vaccines have been developed and have been used extensively to protect troops in plague areas.

b. **Endemic or Murine Typhus.** This rickettsial disease also is transmitted to man by the feces of an infected rat flea and occasionally by inhalation of dust containing infected particles of flea feces. Murine typhus is endemic throughout the Southwestern and Gulf Coast States in the US, through southern Texas, and west into California. It has been reported also from Hawaii, Mexico, parts of South America, Southern and

Western Europe, Australia, Africa, The Near East, Eastern Asia, and the Federated Malay States. It is similar to, but a much milder disease than, epidemic typhus, which is transmitted from man to man by the human body louse and is not a disease of rodents.

c. **Leptospirosis (Weil's Disease or Infectious Jaundice).** Human infections result from contact with the infected urine of animals, including rodents. The spirochetes, which are found in water, mud, or on moist foods, may enter the human body through the mucous membranes or through breaks in the skin. Infections in persons who swim in contaminated waters are reported with increasing frequency. Weil's disease is an occupational hazard to veterinarians, animal husbandmen, slaughterhouse workers, and fish workers, as well as to all those who work or live in rat-infested premises. Distribution of reservoirs of infection and of the leptospira is probably worldwide. The disease is most prevalent in regions where rodents are numerous, particularly in third world countries with warm, moist climates.

d. **Ratbite Fever (Haverhill Fever) (Sodoku).** Two diseases are included under the general term of ratbite fever; one, also known as Haverhill fever, is caused by Streptobacillus moniliformis; the other, also known as Sodoku, is caused by Spirillum minor. The bacteria, which cause these disease are found on the teeth, gums, mucous membrane of the mouth, and blood seeping from the tissues, as well as in the saliva and the conjunctival secretions of infected rodents. The wound caused by the rat bite is thus contaminated by these secretions. Blood from laboratory animals also is sometimes a source of infection to man. Localized epidemics of Haverhill fever are suspected from contaminated milk products, but the means of contamination is not known. The distribution of the disease is worldwide. Proven cases have been reported from Great Britain, Holland, Germany, Italy, East Africa, equatorial Africa, the US, the West Indies, South America, the Philippine Islands, Indonesia, Australia, and India. Sodoku is more prevalent in the Orient, particularly in Japan.

e. **Tularemia.** Tularemia is an infectious bacterial disease of wild animals and man. The reservoirs of infection include many species of wild and some domesticated animals; wild rabbit and hare, woodchuck, coyote, muskrat, opossum, tree squirrel, quail, skunk, water rat of Europe, cat, deer, dog, fox, hog, sage hen, sheep, and bull snake. The disease is transmitted through the bite of infected flies or ticks; by inoculation of the skin or the conjunctival sac through handling infected animals, as in skinning, dressing, or performing necropsies; or by fluids from infected flies, ticks, birds, and mammals. The deerfly Chrysops discalis, the wood tick Dermacentor andersoni, the dog tick Dermacentor variabilis, the Lone Star tick Ambloyomma americanum, and in Sweden, the mosquito Aedes cinereus have all been associated directly with the transmission of this disease in nature. Laboratory infections are relatively frequent. Tularemia occurs throughout North America and in many parts of continental Europe and Japan. It is unknown in Australia.

f. **Rocky Mountain Spotted Fever.** This is a rickettsial disease transmitted from animal to animal and from animal to man through the bite or crushed tissues of infected ticks. The vectors and reservoirs of the disease are infected ticks. Additional

reservoirs include rabbits, field mice, and dogs. The infection is passed from generation to generation in ticks and probably is maintained by infected tick larvae feeding upon susceptible wild rodents. It occurs throughout most of the US during Spring and summer, but it is most prevalent in the Middle Atlantic Seaboard States. Infection also occurs in western Canada, western and central Mexico, Colombia, and Brazil. Infection rates in man generally are directly proportional to the contact with infected ticks.

g. **Tick-Borne Relapsing Fever.** The disease is caused by a spirochete and is transmitted through the bite or the leg joint fluid of an infected tick belonging to the genus Ornithodoros. The vector is an infected tick, while the reservoir is the wild rodent population. The disease is widespread throughout tropical Africa. The disease also occurs in Spain, North Africa, Arabia, Iran, India, parts of Central Asia, as well as in North and South America. In the US, human cases have occurred in limited localities of 13 of the Western and Central States.

h. **Scrub Typhus (Tsutsugamushi Fever, Japanese River Fever, Kedani Fever, Mite-Borne Typhus).** This rickettsial disease is transmitted by the bite of infected larval mites (chiggers) of Trombicula akamushi and related species, which vary with locality. Transovarian transmission occurs in mites, and the infection is maintained in nature by a mite-wild rodent-mite cycle, with man being an "accidental" host. Scrub typhus occurs in eastern and southeastern Asia, northern Australia, the Indian subcontinent, and adjacent islands.

i. **Korean Hemorrhagic Fever.** This disease occurs in troops in Korea generally near the 38th parallel. The infectious agent is a Hantaan virus suspected of being maintained in nature by rodents with man being an accidental host. The vector is a trombiculid mite. Recent evidence, however, has indicated that the causative organism may be transmitted by aerosolization during the cough of a mouse.

j. **Other Diseases.** The bacteria, which cause various types of food poisoning infect rats and mice and are transmitted to man through the contamination of foodstuffs with rodent feces and urine. Intestinal parasites, such as tapeworms, may be transmitted similarly. Trichinosis may be acquired by rodents and then maintained at a high incidence in the wild population through cannibalism. Hogs become infected with trichina by eating infected rodents. Man, in turn, may acquire the disease by eating improperly cooked pork.

1-4. ECONOMIC IMPORTANCE

The importance is fourfold:

a. Destruction or contamination of foodstuffs by rodents amounts to millions of dollars annually.

b. Damage to buildings and manufactured goods are estimated in the millions of dollars per annum.

c. Damage to insulated wiring, earthen dams, and forest products costs additional dollars each year, and the damage to the insulation of electrical wiring creates fire hazards.

d. To the costs of disease and of damage, destruction, and contamination should be added to the cost of rodent control and totals billions of dollars.

1-5. DISTRIBUTION--GEOGRAPHIC RANGE

a. **General.** Domestic rodents, the Polynesian, and the lesser bandicoot are most abundant in eastern and southeastern Asia. All evidence indicates that the Norway rat, the roof rat, and house mouse are native to Asia and have spread from there throughout the world.

b. **House Mouse.** It appears that the house mouse first moved from Asia into the Mediterranean area and then into Western Europe. From there, man carried it to the New World during his early explorations. Because the mouse is so small and requires so little food, it has spread much farther than the rats. Today it is found from the Tropics to the arctic regions all over the world. In North America, it is found throughout the US, southern and western Canada, and the Alaskan coastal regions and Aleutian Islands. It probably has the widest distribution of any mammal except man.

c. **Roof Rat.** When one tries to trace the story of the spread of the roof rat through history, the thread is just along about the 11th Century. At that time, however, it was busy over most of Europe. A guess is that it entered Europe via the Mediterranean area during the Crusades. In the European area, the roof rat has two distinct colors; the black rat of Western Europe, and the brown Alexandrine rat common around the Mediterranean. When this species was carried to the Americas, however, this situation changed. These introductions into North America began well before 1750, and roof rats were well known throughout the French, English, and Spanish colonies. Here the colors from all parts of Europe were dumped together in the same ports, where they interbred freely. As a result, today in North America all the colors can crop up in one population. Often a single litter of young roof rats will contain both black and brown animals.

d. **Norway Rat.** There is evidence that the Norway rat is a later, more highly developed species originating in or near the center of origin of the Rattus group. This comparatively latecomer is adapted to the plains of Central Asia. It is characteristic among mammals that the most advanced species of a group are found closest to the center of origin, where they replace the more primitive forms. So it appears to be with rats. As the more highly developed, more aggressive Norway rat spread outward from Asia, the more primitive roof rat disappeared over much of its original range. The Norway rat first appeared in Europe in the 1700's. It spread so rapidly that the Europeans called it the "Wanderatte" or migratory rat. Soon after it reached Western Europe, it was carried to the New World, where it quickly began spreading outward from the seaports, especially along the east coast of North America.

e. **Polynesian Rat.** The Polynesian rat accompanied Polynesians and Micronesian voyagers from Southeast Asia as a self-replenishing source of food. It is found in Hawaii.

f. **Lesser Bandicoot.** The lesser bandicoot, scourge of Southern Asia, gorges in grainfields and granaries, hoarding in its burrow 4-8 times as much as it devours on the surface. In recent years, the bandicoots have spread from the fields to become the dominant rat in most of India's villages and cities.

1-6. ENVIRONMENTAL DISTRIBUTION

a. **General.** Within their geographic range, the rats and mice are distributed sporadically and are only abundant in certain environments. This distribution is due to differences in the suitability of the various kinds of available environments and reflects differences in the habits and needs of these three species.

b. **House Mouse.** The house mouse has the widest distribution of the three commensal rodents and appears to be the least dependent on man over most of its range. It nests close to its food supply and therefore usually more productive than the roof rat or the Norway rat. It is found throughout the US. In some areas of the Southwestern US, they are more abundant than any other species in cultivated and recently abandoned fields. They have been captured in open tundra in Alaska miles from any human settlement and have been found living 1,800 feet underground in a coal mine.

c. **Roof Rat.** The roof rat is most common today through the Tropics. This is true both in its native area and in areas where it has been introduced. In the US, it is mainly confined to the warm southern states, along the Pacific Coast on into Western Canada. They prefer rural areas and seacoast towns. It is only sporadically found in the northern and central states. When the roof rat and the Norway rat compete for the same area, the roof rat soon disappears from that area. The roof rat seems to be less dependent on man than the Norway rat and it is common for them to live in wooded areas away from man. The majority of the rural rats of the southeastern US are roof rats.

d. **Norway Rat.** The Norway rat prefers the temperate areas, but if all the other environmental needs are present in abundance, it will live in the tropic regions. It is big, aggressive, tolerates cool weather, and prefers urban habitats. The Norway rat is distributed throughout the US and southern Canada. There are areas within the geographic range of the Norway rat where its numbers are very low. This is especially true in the mountainous and arid regions of the West. Throughout most of its range in North America, the Norway rat is closely associated with man and his buildings. In certain situations, however, it can survive quite independently of man.

Section II. LIFE HISTORY AND BEHAVIOR

1-7. GENERAL

Information on the life history and behavior of rodents suggests a great similarity in their birth, development, and general activity. Facts on any one species are sporadic and incomplete. Because of this, these phases of their biology are treated as a unit rather than by individual species. In this way a more coherent idea of the rodent's life may be gained.

1-8. BIRTH AND DEVELOPMENT

a. The life of the average rat or mouse is fairly short--approximately one year--and the young mature rapidly. The Norway and roof rats are born, on the average, 22 days after successful mating has been accomplished. The house mouse requires even less time, producing young at the average of 19 days after mating. Female rats and mice can mate within 48 hours after giving birth, which makes it possible to produce young almost continuously. Under ideal conditions, a single pair of captive rats has produced 1,500 descendants in one year. Fortunately, several things act to slow this reproduction. Mating is not always successful, or is not even attempted immediately after the young are born. Then, too, if the female is nursing young and is also pregnant, birth of the new litter may be delayed as much as a week, with the delay depending on the number of the nursing young and size of the unborn litter. No other rat matches the lesser bandicoots reproductive rate. The females begin bearing young at 2 months and produce 7 pups every month thereafter.

b. Young rats and mice enter this world none too gently, and birth is precarious at best. Large litters are the rule, and in the confusion at birth some of the newborn may be killed and eaten. The female is very nervous, and disturbances to the nest, or intrusions by others, may result in destruction of the litter by the mother. Often following such disturbances, the mother will move the young to another place and many litters thus moved do not survive. It has been observed that slightly more than 50 percent of all rats and mice die before being weaned, and that only 5 percent live for a year.

c. Newborn rats and mice are practically helpless. They are hairless, their eyes and ears are not open, and they have a very limited means of mobility. During this early period, mice and rats respond largely to heat and touch, although they probably have some ability to smell. Their ears open in about 3 days, but rats show no signs of hearing until 12 days of age, whereas the mouse may be sensitive to sound at only 4 days of age. In all species, fine hair appears on the body in about a week and their eyes open at about 12-14 days of age. At this age, the young are already active and enter a period of intense investigative behavior. They begin to take excursions out of the nest, often as result of following the mother when she leaves. For about 3 weeks, the young depend on the mother for food but begin to take solid food in the middle of the third week. If forced, the young can survive without their mother after 3 weeks of

age. Except for sexual behavior and fighting, their activity is essentially adult behavior. Sexual maturity is reached at the age of 2 to 3 months.

1-9. GENERAL ACTIVITY

a. Young rats and mice gradually become familiar with their surroundings, undergoing a "training" period in company with their mother. Their first trips away from the nest are often by accident. Nursing young, clinging to their mother's nipples, are sometimes dragged from the nest as she leaves. Later, they may follow her for a short distance when she leaves the nest. This habit of following increases until finally they regularly accompany her as she goes about her normal activities. During this period, they learn their home area by associating with and imitating their mother. However, there is no evidence that she consciously tries to teach them. They learn by imitation and experience, part of the latter being gained when they accompany each other on forays. By the time the youngsters are 3 months old, they are very active and are completely independent. This level of activity remains high until they are about 9 months old, when old age overtakes them and they slow down.

b. There appear to be certain daily patterns of activity among rats and mice. When food is abundant, the rat shows the greatest activity during the first half of the night. A number of studies showed that the rat becomes most active at or shortly after dusk and that this activity continues until about the middle of the night. The house mouse shows a similar pattern of nocturnal activity, and in addition shows a second lesser activity peak starting well after midnight and lasting until dawn. This latter may also be the case with many rats. Superimposed on this nocturnal activity are short periods of restlessness and activity occurring every few hours throughout the day and night. These shorter activity periods are related to periodic stomach contractions in the rat. The major pattern of nocturnal activity breaks down, however, when the individual is hungry. In one experiment, the amount of available food was cut below the daily needs of caged rats and mice. They quickly shifted their peak of activity to the period when the food was added to the cage. Even when it was added during daylight, they were most active at feeding time. These habits of laboratory rats appear to hold true in the field. There is some conflicting evidence from the field on house mouse activity. On a Maryland farm, more house mice were trapped during daylight hours than at night. It is possible that this daytime activity was related to the absence of cats and other enemies on the farm. Then, too, much of this daytime activity was in the relatively dim interior of barns.

c. Knowing where rats and mice are likely to go is important in such procedures as ratproofing. They like to use regular paths or runways, especially along walls or objects that present a vertical plane. When a rat or mouse wants a piece of food, it will run under and behind things until it gets as close to the food as it can. Then, if the food is in the open, a short dash is the only exposure to danger. The farther away from runways that traps or baits are placed, the less is the likelihood that they will be visited.

1-10. HABITS AND BEHAVIOR

a. **Reaction to Strange Objects.**

(1) Rats very often carefully avoid strange objects, even strange food. Since strange objects may be dangerous or even deadly, it is to the rodent's advantage to investigate them very cautiously. This "strange-object" reaction has led to many stories about the "wily" and "highly intelligent" rat. The answer is a great number of these stories is that the rat recognized the trap only as a strange object to be avoided, not specifically as a trap. Probably one of the reasons that the last few rats or mice in a building are so difficult to kill is that these survivors have the strongest reaction to strange objects. Hence, they avoid all new attempts to kill them. Mice, on the other hand, are naturally curious (especially the males). They will actively explore any change to their environment.

(2) Several studies have been made which show the effect of strange objects in the rodent's environment. During experiments with wild Norway and roof rats, changing the design of the feeding tray was enough to cause feeding to drop almost to nothing. This reaction would sometimes persist for several nights. Lights left on at night in a normally dark room, or unfamiliar noises, also caused a decided drop in feeding. Even changing the location of a familiar object caused avoidance and a lowering of general activity. On the other hand, complete removal of a familiar object commonly had no effect, even to the extent that rats ran around the place where the object had been rather than taking the shorter route opened to them by removal of the object. These studies also point out that rats may avoid new food for several days. This is an important fact in poisoning operations. When the rat first begins to take a new food, it may only take "token" amounts. If these amounts contain a sublethal dose of poison, they may make the animal sick and thus strengthen the avoidance reaction. This is the biologic basis for the use of unpoisoned bait, or prebaiting, before the poison is added. The feeding studies also indicate that hunger causes the avoidance of strange objects to break down more quickly.

(3) In environments where "strange objects" appear regularly, however, rats and mice may show little or no evidence of the avoidance reaction. This is particularly true in such places as in warehouses where a constant turnover in harborage and food is occurring. Rats feeding on garbage are accustomed to new foods and may accept anything edible.

b. **Climbing.** One should not underestimate the climbing ability of rats and mice. Roof rats and house mice are notoriously good climbers, and other rats can climb very well if they have to. They can climb the vertical walls of most brick buildings or any vertical surface where they can get a toenail hold. Nailheads or screwheads placed too close together can serve as steps for rodents to climb. Smooth surfaces can be climbed if there is a pipe, a corner, or something else against which they can brace their backs. Vine-covered walls are perfect runways, and since the vines afford concealment, they can be used by day or night. It is well to remember that rats and

mice do not climb at every opportunity. They work only as hard as is necessary, and only when they are driven by hunger or lack of shelter will they try the feats mentioned above.

c. **Jumping and Reaching.** Rats can reach as much as 13 inches along smooth vertical walls; therefore, a safety factor must be added to rat guards to make certain that the rodents do not pass. The distance that should be completely clear of possible holding points is 18 inches. Rats can be expected to make a standing high jump of nearly 2 feet. With a running start and a bounce against the vertical surface two-thirds of the way to give them a boost, rats can jump a little more than 3 feet. Under these conditions, even the much smaller house mouse can jump more than 2 feet high. Jumping out and down from a height of 15 feet, a rat can cover a horizontal distance of 8 feet. It can do even better with a running start.

d. **Swimming.** All three of the commensal rodents are good swimmers. This is especially true of rats, and they have been known to swim as much as one-half mile in open water and tread water for three days. If young rats are placed in a tank, they will swim readily. There are reports that rats swim up through floor drains without hesitation. In many large cities, rats use the older sewer systems as regular highways. They can survive being flushed down a toilet and re-enter the building by the same route. Anyone responsible for ratproofing inspection should be familiar with the layout of the major sewer lines in the area to be ratproofed. Information is especially important on small trunk lines that were abandoned but not removed when larger mains were laid. This is very important in cities where the first sewers were made of wood.

e. **Nesting and Harborage.**

(1) Rats and mice will nest wherever safety can be found close enough to food and water. Holes or burrows in the ground may be used for hiding and nesting outdoors. In buildings, rats and mice use double walls, the space between floors and ceilings, closed-in spaces around counters, or any place hidden from view that enemies cannot reach. Generally, rats and mice build their nests in hiding places that are relatively quiet. They gather whatever soft material is nearby, or tear up paper and cloth to line the nest. Rat nests generally are bowl-shaped and about 8 inches in diameter. Occasionally, they are completely roofed over. Mouse nests are similar to rat nests but are smaller, about 5 inches in diameter. Normally, they are covered, and entrance is through a small hole in one side.

(2) In addition to disclosing nesting sites, a careful search may reveal hidden resting and feeding stations. These are places safe from enemies where rats and mice can eat or rest undisturbed and are usually found somewhere between the food supply and the nest or burrow entrance. To these spots, the mice and rats carry or drag food, and they leave behind feces, food wrappings, and scraps. The ideal condition, of course, is where harborage is such that runways, too, can be concealed. Too often this condition is found around man's dwellings and business places.

f. **Burrowing.** The rodents differ considerably in their tendency to burrow. This habit is most highly developed in the Norway rat and lesser bandicoot; and as an adaptation to burrowing, the ears of this species are small, and hairs in the ear openings keep dirt out. The roof rat and Polynesian rat are more adapted to a life of climbing, and burrows only in areas where Norway rats are absent. Its burrow system is seldom extensive. House mice burrow where other harborage is not available. In and around buildings, mice seldom have trouble finding cover, but in open fields they burrow extensively. Rats normally burrow no more than about 18 inches downward and about 3 feet horizontally. There are reports, however, of rats digging to a depth of 5 or 6 feet and of tunnels under sidewalks running the entire length of a city block. These longer tunnels are usually made when the rats are searching for food. Their burrows will usually contain, in addition to the entrance, one or more escape exits that may be lightly covered with dirt or loose vegetation.

g. **Gnawing.** Nature seldom has provided an animal with a more effective cutting tool than the rodent's front (incisor) teeth. Young rats and mice begin to gnaw as early as the second week of life. Throughout their lives, the teeth keep growing rapidly. In adult laboratory rats, the average growth for upper incisors is 4 1/2 inches a year, and the lower incisors grow 5 3/4 inches. This fast growth allows continuous gnawing without wearing out the cutting edge of the teeth. Rats and mice will gnaw almost anything. Some of this gnawing may be only to keep the teeth short; it seems to serve no other purpose. To get to food, rats and mice gnaw any material with a gnawing edge that is softer than the enamel of their teeth. This includes such things as wood, paperboard, cloth sacks, lead pipes, cinder blocks, asbestos, and aluminum. Roof rats are even better at gnawing than are Norway rats.

h. **Food Habits.**

(1) Foods eaten. The Norway rat and the house mouse originally came from grain-producing regions in Asia, where their diets probably consisted largely of this sort of food. Knowledge concerning the type of country in which the roof rat originated is more obscure. Nevertheless, all rodent species have become adapted to a very wide range of foods. The choice of food is determined largely by the environment where the rat or mouse is living. In instances where food was difficult to obtain from man, reports tell of Norway rats stealing eggs, roof rats becoming serious pests in citrus groves, and of house mice feeding extensively on insects.

(2) Foods and growth. Differences in the nutritive value of available foods produce obvious differences in the sizes of rats and mice. Studies comparing farm rats and city rats have shown the city rats to be much bigger. The farm rats ate only corn, commercial horse feed, and fresh manure; the city rats, on the other hand, had a well-balanced diet of garbage. When farm and city rats were given the same diet, they grew at the same rate, indicating that most of the difference in size was due to difference in diets.

(3) Amount eaten. Knowing how much food and water rats and mice need is valuable in control work. For example, it helps in determining the amount of poison to put into bait material. Since rats and mice need only limited amounts of food and water, enough poison must be used so that normal feeding will give them a lethal dose. The average adult rat eats about 1 ounce of dry food a day and drinks 1/2 to 1 ounce of water a day. Mice, because of their small size, need less than rats. They eat an average of only 1/10 ounce of dry food a day and take an average of 1/20 ounce of water in each drink. In cold weather, mammals normally eat more to maintain body heat. In the very gregarious mice, however, huddling to keep warm cuts down trips to food sources, and food consumption is decreased.

(4) Feeding habits. The feeding habits of rats and mice are sufficiently different to make some differences in their control. All rodent species have regular eating habits. Rats usually begin searching for food a little after sunset each day; however, mice, being small and hard to see, may come out during the day whenever possible. Rats all treat food much the same way once it has been found. Usually they carry it to a hiding place before eating it. Rats and mice will eat in the open only if they are starved, if no enemies are around, or if the pieces are too big to move to cover. Rats will sample a large variety of foods until they find a food source they like. Then they eat until they are full. Mice nibble and eat constantly, only taking a little food from any one source. Hence, in efforts to poison mice a great many baits should be put out quite close together to make sure that the mice nibble enough to kill them. Rats will normally become satiated on one food and will no longer work to obtain it, although they will work to some extent to get at other foods. Using a bait quite different from food already available to the rat or mouse may increase the probability of the bait being eaten. One approach is to make several different baits available. The one taken the most readily will most like be best for poison baiting.

i. **Senses.** How well the rodents know the world they live in depends on the keenness of their senses. Their reactions to control efforts are the direct result of their perception. Knowing what things rats and mice can detect is of obvious value to persons attempting to destroy them.

(1) Touch. Touch is one of the first senses useful to rats and mice while in the nest. It is also important throughout life, especially since most often they operate in the dark. In addition to the normal ability to feel, such as man has in his hands and feet, the rodents have highly sensitive whiskers, or vibrissae, and guard hairs. At the base of each whisker is a complex nerve net to provide a high degree of sensitivity. Rats and mice seem to prefer running along walls or between things where they can keep the whiskers in contact with the sides. This undoubtedly helps them travel in the dark byways where they often live. The guard hairs are hairs that are longer than the others, scattered throughout the rodent's fur. Apparently they are more sensitive to touch than are the shorter fur hairs covering the body.

(2) Vision. Vision is not too well-developed in rats and mice, and apparently they are color-blind. If rats are tested with different colors, they respond to brightness but not to color. This can be helpful when using poisons for control. If there is danger that human beings or birds might accidentally eat the bait, a warning color can be

added. Although their vision is not as well-developed as in humans, house mice can identify objects at least 45 feet away.

(3) Smell. Rats and mice have a keen sense of smell. However, little detailed information is available on how this sense of smell governs their activities. Of course, rats and mice readily follow rodent body odor, especially that of the opposite sex. There is little need to worry much about the odor of man on traps or baits. After all, rats and mice live so close to man that his odor is an everyday experience to them.

(4) Taste. Generally, the sense of taste in rats and mice is not as highly developed as in man. Where poisonous materials are not involved, a good rule of thumb is that if man will accept the material, the rodents also will. However, if poison in a bait makes them sick, they soon become "bait shy" for this material——not because they recognize the poison, but because the bait mix made them sick. Some field men believe that rodents eat decayed food only if they have no other food and not because they are unable to taste it. For that reason, experienced workers will insist on fresh bait and often will add a preservative to baits that are likely to decay.

(5) Hearing. Rats and mice can recognize noises readily and can locate them to within six inches. Loud noises cause them to try vigorously to escape. Since many of their activities are carried out in darkness, hearing is of great importance to them.

(6) Balance. Rats and mice have an excellent sense of balance. This can be shown easily by tossing one into the air. Almost invariably it will land on its feet. This sense develops very early, and newborn young can right themselves. It should be remembered that rats and mice sometimes can fall five stories without being injured.

Section III. FIELD IDENTIFICATION

1-11. GENERAL

a. In order to effectively control rodents, one must first be able to identify the particular rodent in question. Therefore, a basic key to identification of commonly found rodents is offered in this section.

b. The initial starting point of rodent identification is to place the animal in proper perspective with the rest of the animal kingdom.

c. The basic taxonomy of rodents is shown below:

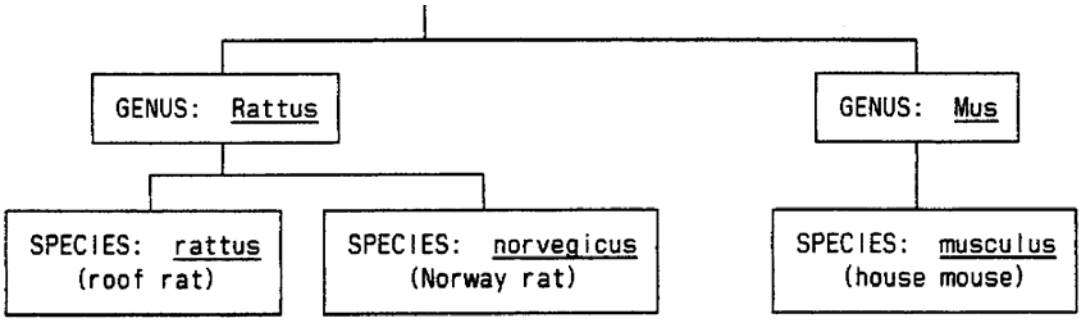
KINGDOM: Animalia

PHYLUM: Chordata

CLASS: Mammalia

ORDER: Rodentia

FAMILY: Muridae



d. The best single way to distinguish rodents from other mammals is by the location and shape of their teeth. Conspicuous are the strong, well-developed front teeth, or incisors. There is a single pair of these prominent incisors in both the upper and lower jaws. The incisors are separated from the molars by a decided gap. In North America, the only similar tooth arrangement is found in the rabbits, hares, and pikes. These species have two extra incisors behind the front pair in the upper jaw. Because of these extra incisors, they are placed in a different order of mammals, the Lagomorpha.

e. The three domestic (taken from Family Muridae) rodents may be distinguished from our native rodents by the character of their tails. The tails of domestic rodents generally are more naked and scaly than those of the native rodents.

1-12. DESCRIPTIONS

a. **Norway Rat (Brown, Sewer, Wharf, House, or Barn Rat) Rattus norvegicus.**

(1) This is the most common and the largest domestic rat in the US. Full-grown specimens usually weigh between 10 and 17 ounces (280 to 480 grams). The coloring varies from reddish brown to black on the back and sides. The belly is grayish or yellow white. The body is thicker, and the head blunter, than in the related roof rat. The muzzle is blunt, and the ears are small and densely covered with short, fine hair. The female has 12 mammae (teats). The tail is shorter than the combined head and body length and is distinctly light in color on the underside. The range of travel for this rat is 100 to 150 feet. Norway rats reach sexual maturity when they are 2 to 3 months old. A female rat may raise from four to seven litters a year, with an average of eight to 12 young per litter. A life span of about 1 year is the same for all three domestic rodents.

(2) The Norway rat is distributed throughout the world. It is somewhat less agile than other species and prefers to burrow for nesting. It is only a fair climber and so usually confines its activities to the lower parts of buildings. It is an expert swimmer and often occurs in great numbers along the banks of canals and other waterways. At times it may live in the fields, particularly in the vicinity of dumps and similar food sources. Normally, however, it occurs in or near buildings, where it prefers narrow

runways and habitually follows the same courses. It is found in basements, in burrows under slabs or the floors of unexcavated buildings, in dumps or rubbish piles, in earthen banks, in waterfront riprap and jetties, in drains and sewers, and in houses, docks, piers, and warehouses.

b. **Roof Rat.**

(1) The roof rat or Alexandrine rat (Rattus rattus alexandrinus), the black or ship rat (Rattus rattus rattus), and the fruit tree, white-bellied, or yellow-bellied rat (Rattus rattus frugivorus) are closely related, with generally similar habits. Full-grown specimens range in weight from 4 to 12 ounces (110 to 340 grams). The tail of the adult rat is longer than the combined length of head and body and is uniformly colored. The ears are noticeably larger than those of the Norway rat and lack the hairy coating of the latter. The female has 10 mammae. The body is slender with a pointed muzzle.

(2) Sexual maturity is reached at the age of 2 to 3 months and the gestation period averages 22 days. There is an average of six to eight offspring per litter and an average of four to six litters per year.

(3) Three color varieties of the roof rat occur in the United States; however, every degree of intergradation occurs between them. Rattus rattus rattus is black to slate-colored on both the back and the belly. Rattus rattus alexandrinus has a tawny back and a belly that is grayish white but is never clear white or lemon-colored. The hairs on the belly are always slate-colored at the base, except occasionally on the throat and chest where the hairs continue the same color to the base. Rattus rattus frugivorus also has a tawny back, but its belly is white or lemon-colored. The hairs on the belly are white or buff-colored to the base. There is usually no gray margin at the line of demarcation between the color of the back and the whitish belly.

(4) The feeding and scouting range of these rats is more extensive than that of the Norway rat. They are excellent climbers and commonly frequent the upper parts of buildings. They seldom live in burrows, preferring to build their nests in attics, trees, and shrubbery. In the absence of Norway rats, however, their nests may be found beneath the floors of barns, feed houses, and similar buildings. Unlike the Norway rat, the roof rat is not fond of entering water.

c. **House Mouse** (**Mus musculus)**.

(1) The house mouse is readily recognized by its small size. House mice will weigh between one-half and three-fourths ounce (14 to 20 grams) at maturity. The color is usually grayish to brown but may be black or pale gray. The underside will vary from white to dark gray. The head and body are small, together totaling only 2 1/2 to 3 1/2 inches (65 to 90 mm). The tail length is equal to or greater than the combined length of head and body. The house mouse is compared with the Norway rat and the roof rat pictorially (see figure 1-2) and descriptively in figure 1-3.

(2) The house mouse reaches sexual maturity in about 2 months and has a gestation period of about 19 days. Offspring average five to six per litter with an average of eight litters per year. The house mouse generally forages for food within 50 feet of the nest.

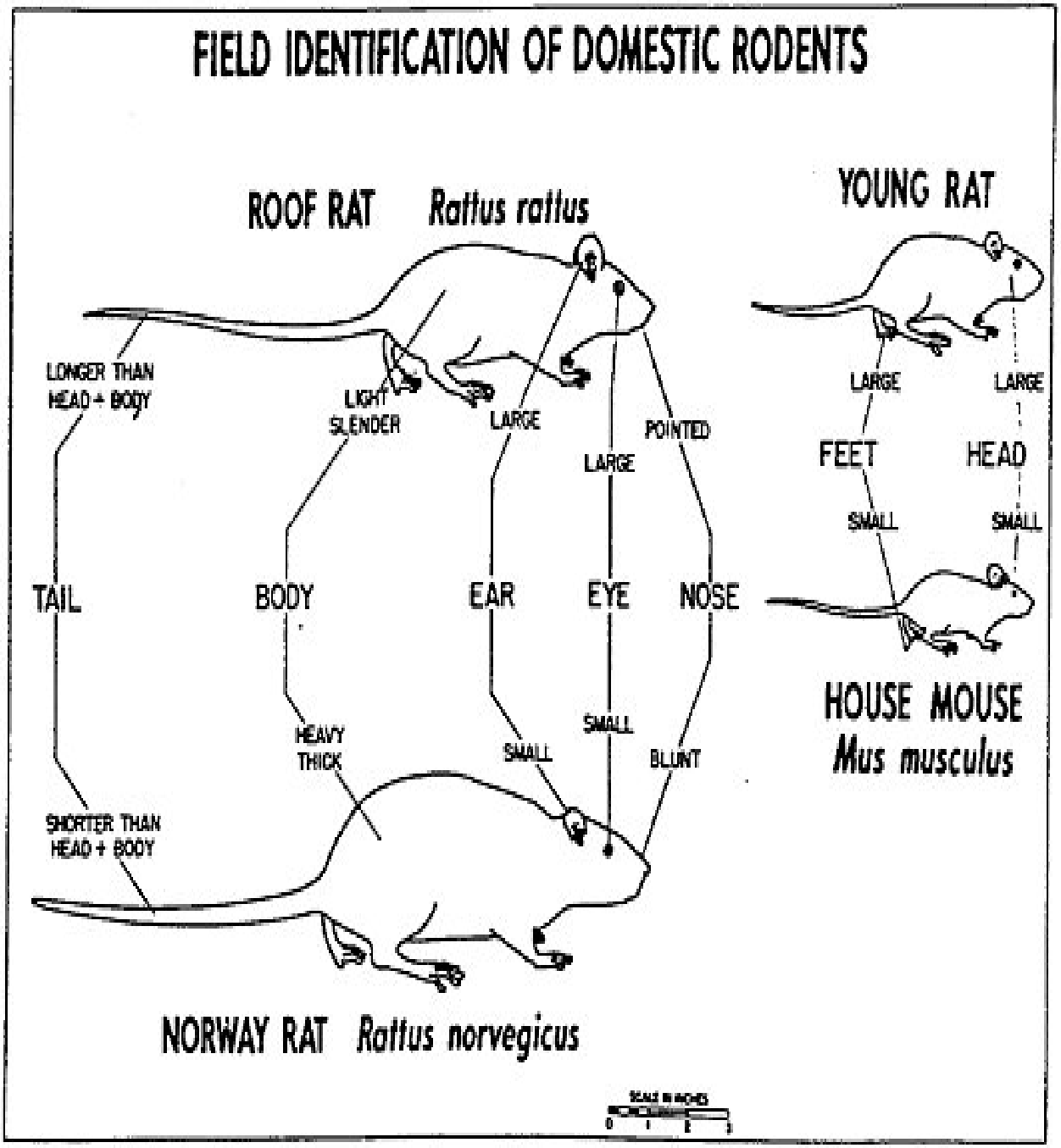


Figure 1-2. Field identification of domestic rodents.

CHARACTERISTICS OF DOMESTIC RATS			
Scientific Name	Norway Rat Rattus norvegicus	Roof Rat Rattus rattus	House Mouse Mus musculus
Weight:	16 ounces	8-12 ounces	1/2 to 3/4 oz.
Color:	Reddish brown hair	Tan to black hair	Gray hair
Body Characteristics:	Thick/blunt nose	Slender/pointed nose	Petite
Tail Length vs Body length:	Shorter than head & body	Longer than head & body	Same as body
Ears:	Small	Large	Large
Droppings:	3/4" long, both ends blunt	1/2" long, one end pointed	1/4" long, one or both ends pointed
Habitat: Exterior Interior	Sewers, trash piles, basements-cellars	Trees & vines Attics	Trash piles pantry or Kitchen
Habits:	Burrower	Climber	Terrestial
Range:	100-200 feet	100-150 feet	10-50 feet
Feeding Habits:	Omnivore/meats	Omnivore/fruits & vegetables	Omnivore/grain & cereals
Food Consumption:	1 1/2 ounces/day	1 ounce/day	1/10 ounce/day
Sexual Maturity:	3-5 months	3-5 months	1 1/2 months
Gestation:	22 days	22 days	19 days
Young Per Litter:	8-12	8-12	5-6
Litters Per Year:	4-7	4-7	8
Weaned Per Year:	20	20	30-35
Lifespan:	1 year +	1 year +	1 year +

Figure 1-3. Characteristics and measurements of adult domestic rodents.

Continue with Exercises

EXERCISES, LESSON 1

INSTRUCTIONS: Answer the following exercises by marking the lettered response that **BEST** answers the exercise, by completing the incomplete statement, or by writing the answer in the space provided at the end of the exercise.

After you have completed all of these exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. Match the following:

   a. Norway rat _____
   b. Roof rat _____
   c. House mouse _____.
   d. All of the above ____.

   (1) The least dependent on man.
   (2) Does not transmit disease to man.
   (3) Life is fairly short, approximately one year.
   (4) Largest domestic rat in the U.S.
   (5) Most common throughout the Tropics.
   (6) Has highly developed vision.

2. It is possible for one pair of rats to produce how many descendants in one year?

   a. 100.

   b. 500.

   c. 1000.

   d. 1500.

3. When there is an abundance of food, at what time of day does a rat show the greatest activity?

   a. During the first half of the night.

   b. Shortly after dusk and shortly before dawn.

   c. During early hours of daylight.

   d. Equally during the day and night.

4. Why has the house mouse had a wider geographical distribution than the rats?

   a. Because it is the most dependent on man.

   b. Because it is a better climber and better swimmer.

   c. Because it is so small and requires so little food.

   d. All of the above.

5. A characteristic that separates domestic rodents from native rodents is their tails. What is the main difference?

   a. Tails of domestic rodents are more naked and scaly.

   b. Domestic rodents normally have longer tails.

   c. Tails of native rodents are much stronger.

   d. There is no significant difference.

6. A rodent-borne disease caused by Yersinia pestis is:

   _____.

7. Stories about the "wily" and "highly intelligent" rat have evolved from which of the rodent's behavioral habits?

   a. The ability to climb vertical surfaces.

   b. Its reaction to strange objects.

   c. Its independence from man.

   d. The ability to find well-hidden foods.

8. The Norway rat is an animal of the _____ climates.

   a. Tropical.

   b. Arid.

   c. Temperate.

9. Leptospirosis is spread by _____.

10. Match the following:

a.	House mouse.	(1)	Good climber.
b.	Roof rat.	(2)	Burrows for nesting.
c.	Norway rat.	(3)	Forages for food within 50 feet of nest.

11. If you find a full-grown, domestic rodent weighing between 110 and 340 grams, with a tail longer than the combined length of head and body, it is probably a

    _____.

12. At what age do young rodents become completely independent of their mothers?

    a. 1 month.

    b. 3 months.

    c. 5 months.

    d. None of the above.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 1

1. a. (4) (para 1-12a(1))
   b. (5) (para 1-6c)
   c. (1) (para 1-6b)
   d. (3) (para 1-8a)

2. d (para 1-8a)

3. a (para 1-9b)

4. c (para 1-5b)

5. a (para 1-11e)

6. Plague. (para 1-3d)

7. b (para 1-10a)

8. c (para 1-6d)

9. Rodent urine. (para 1-3c)

10. a. (3) (para 1-12c(2))
    b. (1) (para 1-12b(4))
    c. (2) (para 1-12a(2))

11. Roof rat. (para 1-12b(1))

12. b (para 1-9a)

End of Lesson 1

LESSON ASSIGNMENT

LESSON 2	Rodent Survey Procedures.
LESSON ASSIGNMENT	Paragraphs 2-1 through 2-4.
LESSON OBJECTIVES	After completing this lesson, you should be able to:

2-1. Identify a rodent infestation by all natural rodent signs present and/or by trapping.

2-2. Determine the extent of the infestation and note all harborages and signs necessary to formulate an effective control operation.

SUGGESTION After completing the assignment, complete the exercises of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 2

RODENT SURVEY PROCEDURES

2-1. INTRODUCTION

a. Rodent survey and ectoparasite survey are the first steps planning an effective rodent control program. Methods of rodent control will be covered in Lesson 3. This reason will be concerned with determining if a rodent infestation exists, the degree of infestation, the species of rodent involved, and the ectoparasites present. A basic understanding of rodent habits will give the surveyor a lot of valuable information. Rodents, because of the way they live, furnish many details of their population to a trained observer. The rodent will even give indications of its food preferences and other intimate details of its personal life. When all of the data are collected and deciphered, the control team will be led to the rodent nests, runways, sources of food and water.

b. In areas where rodent-borne diseases may constitute a problem, it is recommended that specimens of the animals and their ectoparasites be collected and examined for evidence of these diseases. Generally, two specific objectives must be considered when conducting a survey of this type. First, the presence of the etiological (causing) agent of the specific disease in the collected specimens; and second, the population dynamics of the particular population. The two objectives can be satisfied only if a comprehensive survey program is initiated. Knowing of the presence of an etiological agent in a rodent population is of little value if the population density, ectoparasite density, breeding habits, home ranges, and migration tendencies of the population are not also known.

2-2. EVIDENCE OF INFESTATION

Observation of rodent signs is essential in ascertaining whether rodents currently infest buildings, in determining the degree of infestation, and in planning effective control programs. These signs are droppings, runways, tracks, burrows, nests, damage, rat odor, live rats, dead rats, and damage to stored products.

a. **Droppings.** The most frequently observed sign of rat infestation is rat droppings. (See figure 2-1). Rat droppings are rod shaped, with rounded ends. They vary in size from one-fourth inch long by one-sixth inch in diameter to three-fourths inch long by one-fourth inch or slightly larger in diameter. Droppings of young rats may not be distinguishable at times from those of mice, although mouse droppings tend to be more pointed at one end. When droppings of various sizes are found, the presence of both adult and young rats usually is indicated. The age of droppings is an indication as to whether a building currently is infested. Fresh droppings are soft enough to be pressed out of shape and often have a glistening, moist appearance. Color varies with the food eaten but usually is black or nearly black. Within a few days, depending on climatic conditions, droppings become dry and hard. Later, the surface become dull,

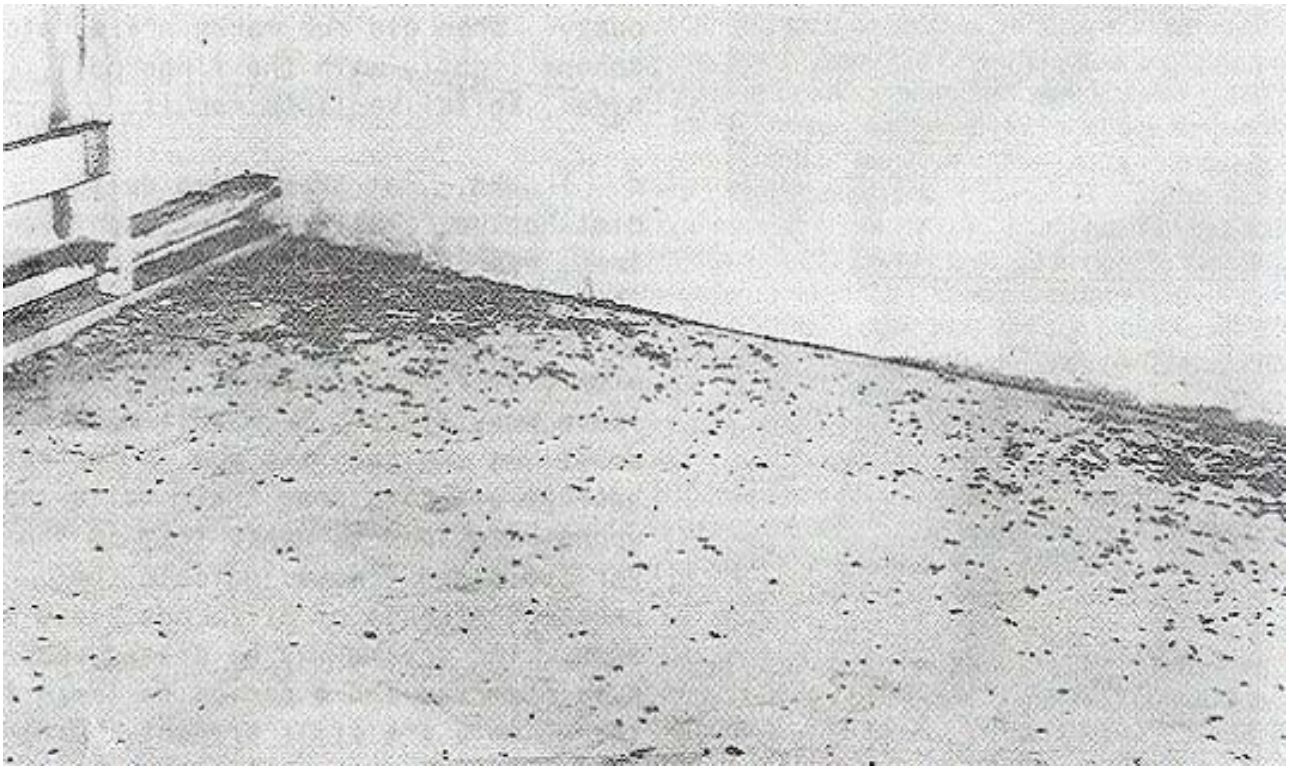


Figure 2-1. Rat droppings in a basement.

assuming a grayish, dusty appearance, and the droppings may crumble easily when pressed. Droppings are found wherever rodents occur, but they are more numerous along their runaways, near their harboring places, and in secluded corners. Droppings may be found scattered also on the tops of goods stored in a building. The number of droppings found in a building will depend on the rapidity of the turnover of its contents and how frequently the building is cleaned, as well as on the size of the rodent population. Rat urine will fluoresce under ultraviolet light, as will some other materials. The presence of fluorescent patches in an area does not alone prove the presence of rats.

b. **Runways.** Runways usually lead to some point where the rodents are entering the building, to one of their interior harboring places, or to places where they drink or feed. The fur of rats is covered with oil and dust; whenever they rub their bodies against a wall, climb a pipe, or pass through a hole or barrier, they leave a greasy deposit. (See figure 2-2). Because rats tend to follow the same end routes, these deposits are built up until characteristic black markings result. Unused rat runs may be distinguished from currently used ones by washing off some of the marks or by covering a portion of the run with white paint; after a few days, new markings can be observed easily. Active runways usually have a shiny, dust-free appearance. Little-used runs may be dusty, with individual tracks apparent; though heavily traveled rat turns will be slick, and no individual tracks will be observable. Sometimes the fact that a run is no longer in use may be seen at once from the presence of unmolested cobwebs

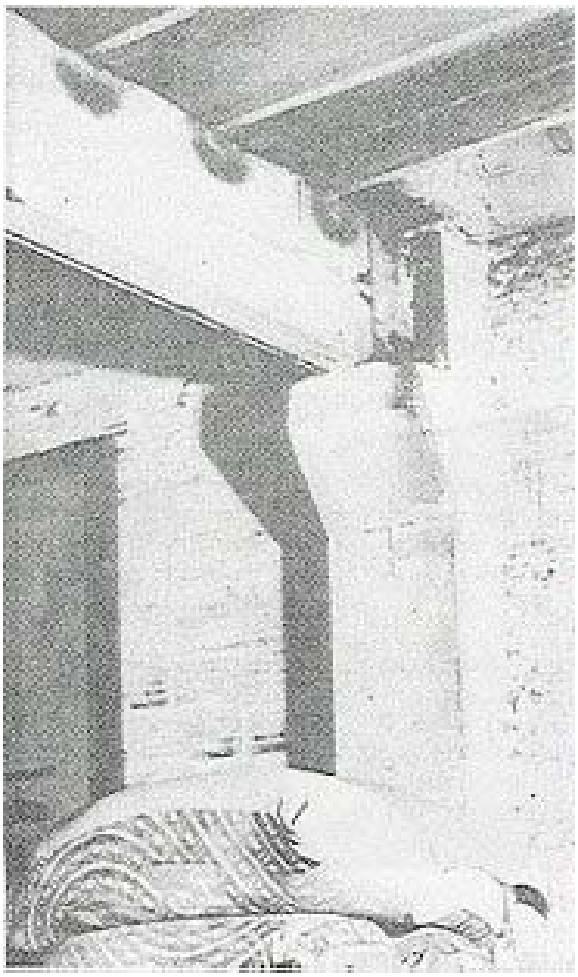


Figure 2-2. Rat runways.

across the runway or a film of dust obscuring the tracks. Additional evidence as to the age and activity of the run can be obtained from a closer examination of the greasy rub marks mentioned above. In active runs, the grease on these marks will be soft and will stick to the finger when touched lightly. In abandoned runs, the grease will be hard and dusty. When old rub marks are scratched across lightly with the fingernail, clear, knifelike lines result.

c. **Tracks.** Rat tracks are quite distinctive. The tracks of the five-toed, rear paws are seen more commonly than those of the four-toed, front paws, but both may be present. When moved slowly over flat surfaces, the tail may leave wavy lines. Such tail markings sometimes indicate the age of the rat because old rats drag their tails and young rats tend to carry them in the air. Various-sized tracks indicate the presence of rats of different sizes and ages. The tracks may be erased, and the site observed for a period to learn if the animals are still present. Ordinary wheat flour or other similar material may be dusted around an area to form a patch in which freshly made tracks will appear.

d. **Burrows.** Burrows may be used as nesting or hiding places or as a means of entrance to buildings. The former are usually 12 to 18 inches deep, and they may extend several feet in a horizontal direction and connect with other burrows and entrances. Rats have been known to burrow almost 4 feet vertically in order to pass under a foundation wall. Active burrows frequently have a pile of newly excavated soil at the entrance; abandoned holes often are closed with undisturbed cobwebs. A sign of use on relatively compact soil is the absence of dust or loose earth, and on loose soil, a more compacted appearance than the surrounding area and the presence of distinct tracks. Burrows will be found along the outside wall of buildings, in dirt basement floors, and around many of the outbuildings of a business premise, residence, or farm. Away from buildings, burrows may be found in embankments, hedge rows, fills, and under heavy vegetation.

e. **Nests.** Rat nests may be found in concealed spots in wasteland, in the corners of cultivated fields, in trees, and in buildings; that is to say, wherever rats find shelter and concealment. The apparent freshness of the material from which the nest is constructed and the age of droppings and food scraps nearby is of some assistance in determining whether the nest currently is used.

f. **Gnawings.** Evidence of recent gnawings is one of the most reliable signs of rodents. A recently gnawed area will be sharp and may show individual tooth marks. These edges become rounded and darkened in a few days, and the small cuttings are soon scattered or swept away. Rats will smooth and enlarge a hole through which they pass, so that is smoothness and enlargement will be an indication that the hole is an old or much traveled route. Young rats can pass through a 3/4-inch opening, and any rat easily can enlarge an opening and pass through the spaces beneath wooden sills, doors, and windows unless these are shielded with metal.

g**. Damage.** (See figure 2-3). Damage to foodstuffs and other goods may constitute the only visible evidence of rat infestation. Rats often will carry small pieces of food into accessible places such as beneath stoves and refrigerators, and these may be taken as a good indication of their presence.

Figure 2-3. Rat damage to subsistence supplies.

h. **Rat Odor.** The characteristic musty odor of rats sometimes lingers for several days in closed spaces.

i. **Live or Dead Rodents.** The occasional observation of a single rat is not enough to indicate the need for a control program, but it does indicate need for investigation. It has been estimated that one rat seen abroad in daylight represents as many as nine others unseen. It should, therefore, be determined whether the occasional rat is an explorer or the representative of a stable population in the area. Inspection of the suspected area with a spotlight at night may disclose feeding rats. Finding dead rats in the open, in the absence of recent poisoning, may indicate disease and always demands thorough investigation by Medical Department personnel. Such rats should not be handled with the bare hands but should be picked up with gloves or tongs, placed in bags immediately and held under refrigeration until an investigation is made.

2-3. SURVEYS OF INFESTED AREAS

Figure 2-4 will assist in converting signs of rat infestation into degree of infestation. It is desired to conduct live trapping of rodent specimens in order to obtain an accurate ectoparasite survey.

a. **Determination of the Problem.** A survey should be made of any area where a rodent population is suspected in order to discover: (1) the particular locations infested, and the relative number of rodents and the species involved; (2) the sources of food and water and possible means of denying them these necessities; and (3) the available harborage or shelter.

b. **Sampling.** While the evidences of infestation enumerated above are important guides in making a survey, it is also desirable to set a number of traps in suspected areas in order to collect specimens and thus to confirm the results of the inspection. In city work, one man servicing 200 traps each day over an area of about 10 blocks, should be able to obtain a satisfactory sample within 1 week. He should inspect all premises and set traps in those where evidence of active rat infestation exists. Traps should be visited each day and removed in 3 days, if there is no catch. More than 10 rats caught per 10 traps set will indicate heavy infestation. Whenever possible, the animals caught and their ectoparasites should be examined for disease in a qualified laboratory. Inquiries should be made among the civilian population near military camps and stations to assess local experience with the rodents concerned. Questioning may bring reports of large concentrations of rodents adjacent to the control area, such as at a city dump. Control on a military post is not likely to be successful if such opportunities for reinfestation occur.

RAT SIGNS OBSERVED	LIGHT 1-20	MEDIUM 21-50	HEAVY OVER 5O
Tracks	Few to moderate in number; usually all of one size.	Moderate to many; Usually of two or more distinct sizes.	Many; two or more sizes; runways in dusty areas usually slick and not dusty.
Fresh Droppings	None or few groups observed; generally all of same size.	Some always seen in two to six to eight areas; usually two distinct sizes.	Many; usually of several sizes; small to large and in at least six locations.
Active Runs	None or few and relatively indistinct.	Several distinct; one or more indicating heavy travel.	Many; more than one heavily traveled run.
Fresh Gnawing	None to few nightly.	Usually several instances nightly.	Many instances nightly.
Live rats Seen	None by day except cleanup and harborage removal.	None to two by day unless harborage is opened up.	Often one or more seen by quiet, close observation, even in daytime.

Figure 2-4. Degree of infestation.

c. **Food Sources.** During the survey, particular attention must be given to all potential rodent food sources, such as dining facilities, commissaries, grain storage warehouses, garbage cans, and garbage and refuse disposal areas. The large concentration of rats at these points frequently makes them centers of infection when rodent-borne diseases occur. Control measures directed at these spots will, therefore, be most effective in reducing the rodent population and retarding the spread of such diseases.

d. **Harborages.** It is quite important to look carefully for situations that present the rodent with opportunities for suitable harborage. Concrete slabs at entries (particularly if the earth is soft or has fallen away slightly beneath the slab), boxes and garbage cans set closely against the building, piles of rubbish, holes in walls, and goods stacked indoors without adequate aisle space to allow access during inspections are all invitations for rodents to enter and to make their habitations.

2-4. ECTOPARASITE SURVEY

a. Prior to attempting rodent control, it is necessary to know the type and appropriate degree of ectoparasite infestation. This information can best be obtained through sample rodent trapping. The recovery of ectoparasites from trapped animals should be carried out while animals are alive, depending on the type of ectoparasites sought. Since most ectoparasites leave the host soon after its death, the collection methods for these types require the use of live traps to ensure maximum recovery. Rodents must be caught alive, in as much as they may be transported in the trap or placed in a building cage or bag for transportation back to the laboratory.

b. Ectoparasites may be recovered from freshly killed rodents by placing the rodent, together with a wad of cotton soaked in chloroform, in a plastic bag until the ectoparasites are stupefied or dead. The rodent is then removed from the bag and held by the tail over a white surface. (Gloves should always be worn when handling rodents). A fine-toothed comb, preferably one specifically designed for that purpose, should be used to comb the ectoparasites from the rodent. The rodent must be combed in the opposite direction in which the hair grows (from the tail toward the head). The entire surface of the rodent should be combed, to include inside the ear openings and the tail. Combing should be done in a manne, which allows the combed out ectoparasites to fall onto the white surface. The ectoparasites may be removed from the white surface and the comb by using a small camel's hairbrush dampened with water. The plastic bag, which was used to hold the rodent should be completely emptied of ectoparasites by dumping, then turning it inside out, and brushing. The ectoparasites removed from the white surface should be placed into a vial containing 70 percent alcohol for preservation and study.

Continue with Exercises

EXERCISES, LESSON 2

INSTRUCTIONS: Answer the following exercises by marking the lettered response that **BEST** answers the exercise, by completing the incomplete statement, or by writing the answer in the space provided at the end of the exercise.

After you have completed all of these exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. Where are rodent droppings normally found?

   a. Around and in nests.

   b. Along runways.

   c. In secluded corners.

   d. All of the above.

2. Finding several distinct runways and seeing evidence of several fresh gnawing instances nightly would indicate the presence of a _____ rodent infestation.

   a. Light.

   b. Medium.

   c. Heavy.

3. Mouse droppings differ from young rat droppings in that they:

   a. Are smaller and lighter in color.

   b. Tend to be more pointed at one end.

   c. Are normally found closer to the nest.

   d. Are larger and darker in color.

4. When combing dead rodents to recover the ectoparasites, what should always be done?

   a. Hold the rodent over a white surface.

   b. Use a comb with soft, well-spaced teeth.

   c. Comb in the same direction the hair grows.

   d. All of the above.

5. One of the most reliable signs of rodent evidence is _____

   _____.

6. Maximum recovery of ectoparasites can best be attained by using:

   a. Snap-traps.

   b. Ultraviolet lights.

   c. Live traps.

   d. 70% alcohol.

7. The first steps in planning an effective rodent control program are

   _____ and _____.

8. Which of the following is the most frequently observed sign of a rodent infestation?

   a. Damage to foodstuffs and stored products.

   b. Live or dead rodents.

   c. Runways.

   d. Droppings.

9. When making a survey, particular attention must be given to all potential sources of:

   a. Diseases.

   b. Entry into the building.

   c. Rat food.

   d. None of the above.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 2

1. d (para 2-2a)
2. b (para 2-4)
3. b (para 2-2a)
4. a (para 2-4b)
5. Recent gnawings (para 2-2f)
6. c (para 2-4a)
7. Rodent survey, ectoparasite survey (para 2-1a)
8. d (para 2-2a)
9. c (para 2-3c)

End of Lesson 2

LESSON ASSIGNMENT

LESSON 3	Rodent Control.
LESSON ASSIGNMENT	Paragraphs 3-1 through 3-10.
LESSON OBJECTIVES	After completing this lesson, you should be able to:

3-1. Formulate and recommend mechanical or chemical control procedures to eliminate or reduce a stated rodent infestation.

3-2. Choose appropriate rodenticides and manners in which they will be offered to the rodents.

3-3. Recommend sanitary practices to effectively reduce future rodent populations.

3-4. Formulate adequate rodent-proofing procedures commensurate with the type and size of a specified rodent infestation.

SUGGESTION After completing the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.

LESSON 3

RODENT CONTROL

3-1. INTRODUCTION

a. Rodents moved in with man several thousand years ago, prepared in his environment, and accompanied him to all corners of the world. We will never eliminate rodents completely, but by employing the techniques discussed in this lesson, we will be able to limit them to the point that they do not pose a threat to the health or economy of the Army.

b. Rodent control work should be regarded as a continuous program, with a sustained effort to eliminate the causes of infestation, rather than a program of recurrent extensive campaigns. Rodent control must be carried out in a logical sequence in order to bring about rodent abatement without spreading rodents or increasing the probability of disease transmission to man. Steps in an effective rodent control program include: survey (to include ectoparasite survey), ectoparasite control, rodent extermination, rodent proofing, environmental sanitation, and maintenance. Survey procedures were discussed in Lesson 2; this lesson will deal with methods of control.

3-2. ECTOPARASITE CONTROL

a. Ectoparasite control is a vital step in any rodent control program. The ectoparasites feed on the blood of their host rodent and may thereby become infected with disease. When the rodent host is killed, the ectoparasites leave the body and, by chance, may select man as the new host. In doing so, the ectoparasites may transmit the disease to man. When disease is thought to be present in a rodent population, the ectoparasites must be killed before rodent eradication measures begin. If the situation is urgent, ectoparasites control can be applied simultaneously with rodent control measures.

b. Ectoparasite control can best be accomplished through the application of residual insecticides at the suspected focus of the rodent infestation. Only insecticides approved by the Environmental Protection Agency specifically for this type of control may be used. Information contained on the manufacturer's label must be consulted prior to use. Harborages, burrows, runways, and similar areas should receive particular attention; however, under certain circumstances, it may be necessary to treat entire buildings or areas of open ground. Ectoparasite control should normally precede rodent killing operations by at least 1 to 3 days. Insecticide dust should be blown or thrown into burrows, nests, harborages, and other enclosed spaces, which could conceal a rat or mouse. The insecticide dust should also be applied in patches along known runways and other areas along which rodents may travel. The applied dust will adhere to the fur of the rodent, thus killing the ectoparasites present on the rodent.

3-3. INTEGRATED PEST MANAGEMENT OF RODENTS

Integrated pest management (IPM) of rodents should follow ectoparasite control by 1 to 3 days. Integrated pest management incorporates cultural, mechanical, physical, regulatory, and chemical control measures, which are generally implemented concurrently. The following paragraphs refer mainly to the control of domestic rats and mice.

3-4. CULTURAL CONTROL

Cultural control, which is the most effective means of controlling rodents, focuses on environmental sanitation. This simply means to change the rodent's physical environment to the point where it will no longer support him. The rodent's physical environment consists of three main parts: food and water, harborage, and climate. Eliminate or limit the rodent's access to any one of these three and the rodent population will decrease.

a. **Sanitation.** Rat infestations usually can be traced to unsanitary conditions, consisting chiefly of inadequate food and refuse storage and poor refuse collection and disposal practices. Good general sanitation as a rat control measure includes: primarily, the inauguration and continuation of debris and rubbish cleanup; adequate garbage and refuse storage, collection, and disposal; the elimination of food scraps; the proper stacking of food supplies; and the elimination of water sources. Such practices strike directly at the rat by reducing his available food and harborage.

b. **Landfill Operation.** Landfill operations may be maintained rodent free, only if the refuse and garbage are well managed and entirely covered with compacted earth at the close of each day's operation. Otherwise, they become focal points of rodent infestation. Where there is a history of rats, the compacted earth cover should be 12 inches thick at the end of each operating day. Where rats have not been a problem, thickness may be reduced to 6 to 12 inches. Improper landfill operations also create problems with other pests to include flies, mosquitoes, cockroaches, and snakes. The rodents' ability to dig and make burrows up to 3-4 feet in depth makes management of rodents imperative. The use of poisons is often necessary; however, live trapping and checking the rodent population for ectoparasites and disease should occur first. The location of landfill sites is also important. When located near waterways, the rodents will often burrow into the banks and thus create another problem.

c. **Combat Operations.** The destruction caused by combat favors rat infestations. In consolidating a new position, the burial of bodies, the rapid disposal of spoiled and damaged food supplies, and other sanitary practices will assist in preventing gross increases in the rat population.

3-5. MECHANICAL CONTROL

a. **Trapping.** The use of traps is largely restricted to survey work; however, under certain circumstances, traps may be used as a method of control. Trapping is recommended for use in those places where it is not advisable to use poison bait or gas. It is also recommended as a follow-up to rodent poisoning to kill any rodents that survive. It is a slow method of reducing populations and it is normally reserved for smell rodent populations. Generally, less than 10 percent of the traps can be counted on to effect satisfactory rodent control. The need for using a large number of traps in all promising locations is therefore evident.

(1) In trapping rats, the proper placement of the trap is far more important than is the selection of a bait. As previously stated, rats follow natural runways whenever possible. Their instinct for security and protection causes them to travel behind anything that is placed near a wall. The best baited trap will rarely entice a rat into the open. When a trap can be set behind objects that are stacked close to the wall or behind a board leaned against a wall, it will be much more likely to lure a rat into investigating it. Live trapping is used to obtain specimens of infected animals in a plague situation and should begin at the center of the infested area and move outward in a radical direction as far as the animals are found. The snap trap is the one of choice, after you have determined that there are no diseases present in the rodent population. Steel traps with approximately 3 1/2-inch jaw spread (size No. 0) are also used (see figure 3-1). Cage and box-type traps are sometimes used when live,

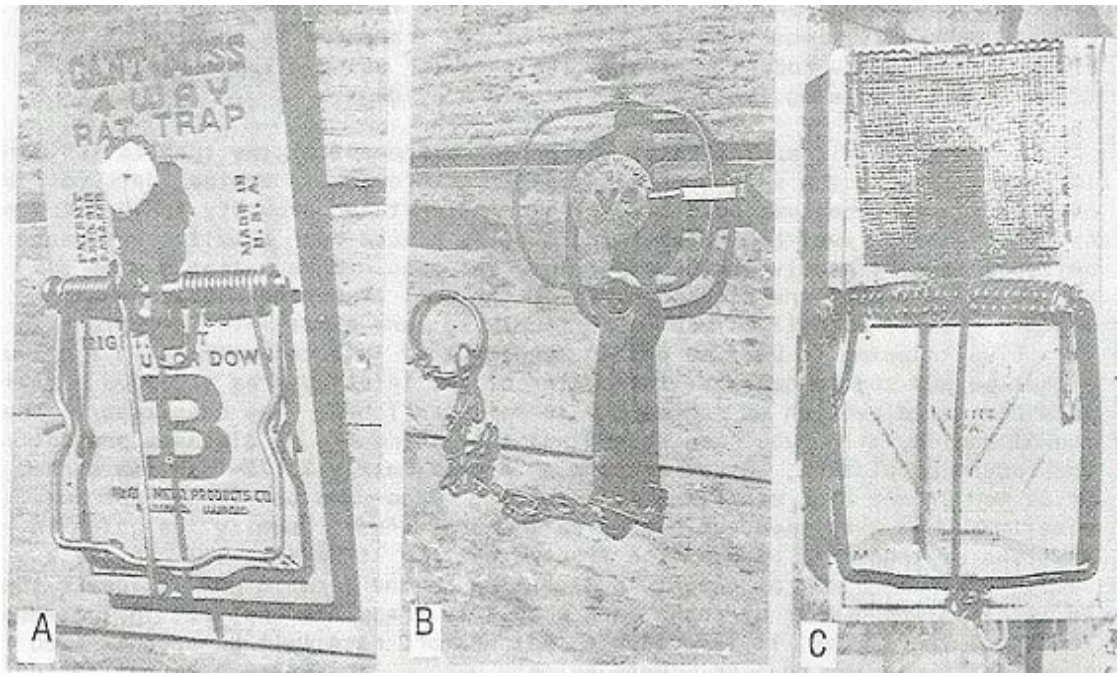


Figure 3-1. Three frequently used rat traps. (A, wood-base snap trap, with bait; B, steel trap, used baited or unbaited; C, snap trap with expanded trigger).

uninjured rats are desired. Usually the catch in any type of trap will be best the first night, so it is essential to set a sufficient number. A rat caught in each trap on the first night indicates that an insufficient numbers of traps were used. If traps are kept set in the same locations for a week, it is probable that no more rats will be caught, even though rats are in the area. Rats quickly become "trap-wise," necessitating frequent changes in settings and baits. If a rat proof building must be entirely freed of rats by trapping, many snap and steel traps should be used in order to catch as many as possible the first night. As the infestation is decreased, the number of traps may be correspondingly reduced. More care then should be taken in the setting and camouflaging of the traps to catch the more elusive rats. In a particularly difficult situation, it usually pays to remove the traps for a week and to use poisoned baits during the interim. Traps require servicing daily and sometimes twice daily. It is best to set them late in the afternoon when there is less chance that they will be sprung by careless people. Much time must be spent in this setting and daily servicing of traps if good catches are expected. Rats often set off traps without being caught. Traps should be cleaned whenever necessary to ensure efficient operation. A trap that rocks in its setting will generally not catch rats, and warped traps are unserviceable. It is not necessary to avoid handling traps, nor is it necessary to wash or sterilize them, because human odors or odors from previously caught rats do not deter rats from approaching them.

(2) Snap traps usually kill rats caught in them. All traps should be set on a hairtrigger so that they will be set off in the slightest touch. A good test of sensitivity is to touch the trigger with a flat piece of writing paper. If this is not sufficient to spring the trap, the setting is improper or the trap needs adjustment. When set, the trigger should be nearly parallel to the base of the trap and should not be up at an angle. Snap traps may be baited or unbaited (see figure 3-2). A solid bait, about the size of the end of

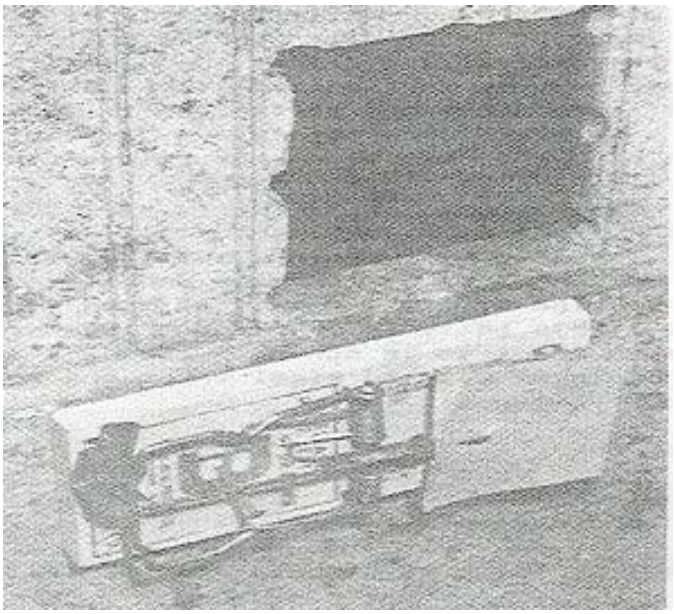


Figure 3-2. Expanded trigger trap set in runway

one's index finger, is tied securely to the trigger. Ground baits may be used but are difficult to fasten properly. Baits may be of any food (listed in the section on poisons) attractive to the rats. The baited traps should be placed near, but not in, rat runs because rats prefer to investigate food and may be wary of obstructions in their runways. Traps near a wall or other vertical surface should be placed about 1 foot from and at right angles to the wall, with the hair trigger toward the wall. Therefore, a rat running along the wall from either direction, in leaving the run, will go straight for the bait on the trigger. Camouflaging traps by sprinkling dust or other light material over all but the bait is desirable, but care should be taken to prevent interference with trigger or spring action. On earth floors, the base of the trap should be worked down into the soil until the top is flush with the ground level. Sufficient headroom for the trap to spring should always be allowed. Baited traps are best trap set in runway. Fastened down, so that a rat caught by the tail or foot cannot drag them away, but this will not always be required. Baits should be changed at least every third day unless a permanent-type bait or a bait with a preservative is used. Rancid bacon or moldy cake usually will not tempt a rat. It is also desirable to vary the bait every few days, switching to an entirely different type. If a bait is eaten from the trigger without springing the trap, the setting is improper or the trap is defective; however, baits sometimes are eaten by mice or insects. Snap traps may be used unbaited if the trigger is enlarged to provide a pattern on which rats may step (figure 3-2). This can be done by fastening a 1 1/2-inch square of fly screen, tin, or cardboard securely to the trap trigger or bait hook. Fly screen, or tin may be soldered to the trigger, or cardboard may be wired in place. Traps so modified are termed expanded-trigger traps or flap traps and must be placed directly in rat runs since there is no lure. Boards, boxes, or other obstacles should be placed beside or immediately behind such traps. Placing of these traps requires knowledge of rat habits; the trigger must know exactly where the rats travel if he is to catch them. The traps may need to be camouflaged for any wise rats that survive after the first few days of trapping. In addition to the usual settings for expanded-trigger traps in rat runs and corners, near burrows, and holes, and in protected secluded areas, they also may be placed on shelves, tops of fixtures, beams, pipes, and other overhead runways. On overhead beams, particularly for roof rats or mice, wood traps can be suspended either horizontally or vertically on the beam, with the trigger in the rodent's normal path. A 1/8-inch hole may be drilled 1/2 inch from the front center of the trap, a small finishing nail driven into the beam at the point of the setting, and the trap hooked over this nail. A string from the back of the trap is tied to a nail in the beam below. Thus, when a rat is caught, the trap is jarred off the nail, and the rat and the trap hang down by the string.

(3) Steel animal traps usually are not used with bait on the trigger, and only an occasional rat is caught by the neck. Steel traps catch rats by the leg or belly. They require careful adjustment, even when new. Any burr of metal on the trigger catch or release lever, which would keep these parts from slipping easily, should be filed off. When properly adjusted and set, the tops of the two jaws and the trigger pan should be in one horizontal plane (see figure 3-3). The height of the jaws is regulated by turning the spring in a counter-clockwise direction. In an adjusted trap, the spring arm will be approximately 45 degrees from the axis of the jaws, and one jaw will fit into a small depression in the spring handle. Each steel trap is provided with for a chain and a ring.

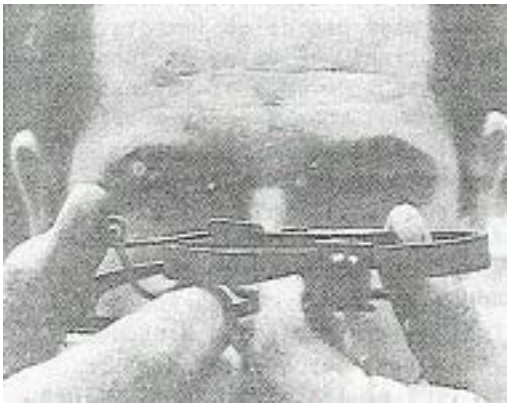


Figure 3-3. Checking steel trap for correct setting.

The chain should be fastened securely to some object so that a rat cannot drag the trap away. It may be nailed to the floor with a staple. To avoid losing rats or having them get into holes, the staples should be placed on the chain as close to the trap as feasible. Traps are placed in rat runs and inside or near the entrance to holes, generally with one on both sides if rats can go in either direction. When placed along a wall, the axis of the trap jaw must be parallel to the wall, with the nearest jaw almost touching it. The best way to test a steel trap is to set it on a table and strike the trigger with a stick held horizontally. If the stick hits the trap along the axis of the jaws, it will be caught, and the trap will have been placed correctly. If the stick hits at right angles to the jaw axis, the trap will spring, but the stick will be pushed up by the jaws and not caught. The same thing will be true for a rat if his belly is over the trigger pan when the trap is sprung. The essentials of setting steel traps are as follows:

(a) Set traps only in rat runs.

(b) Place the traps so that the axis of the jaw is in line with the direction of rat travel, not at right angles.

(c) Move the spring to rest at 30 to 45 degree from the axis of the jaws.

(d) Place the trap so that end of the spring points out from the wall.

(e) Block all runways with boards, boxes, or other objects; place the traps inside the blocked areas or in the most confined parts of the runs.

(f) Fasten the chain away from the rat runs and on or near the floor, never over the run.

(g) Keep the chains from the adjacent traps far enough apart so that a rat caught in one trap cannot spring the second.

(h) Fasten the chain so that the trap cannot be dragged into a hold or wall crevice where the rat will be difficult to remove.

(i) Use tracking patches to determine where traps may be used most effectively.

(j) Camouflage traps with dust or torn paper if rats appear to be circling around them.

(k) On pipes, wire the trap horizontally by running a wire around the pipe and under the trigger pan.

(l) Don't "ring" a rat hole or "line" a run with traps. Two at each hole or one at each end of a run are enough.

(4) Cage traps have an entrance chamber and a bait chamber with an opening into which a rat can go, but by which it cannot return. Cage traps occasionally have to be complete covered except for the rat entrance. Another type of cage trap consists of a wooden box open at one or both ends, having one or two doors, and closed by a lever, which is fastened to a trigger. These are similar to rabbit traps, and catch animals through the use of baits. The trigger may hold the bait or it may be a wire or treadle on which the rat walks inside the box (see figure 3-4).

Figure 3-4. Box trap.

(5) Glue boards have characteristics of both the snap trap and the cage trap. These traps can be placed directly in the run and can be used baited or unbaited. Rodents are trapped live and, if traps are inspected daily, ectoparasite control may not be necessary prior to initiating a trapping program. Sticky traps must be inspected frequently to ensure that they have not become wet or covered with dust thus rendering them ineffective. Ready-to-use traps come in two sizes. One is used for rats and the other for mice. Traps can be made by coating cardboard or similar material with commercially available stick-em type glues (see figure 3-5).

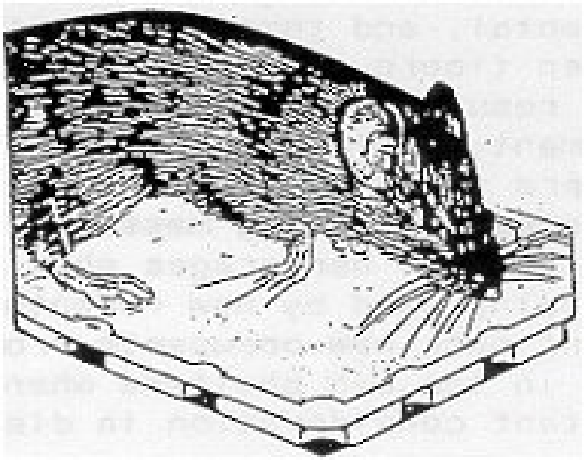


Figure 3-5. Glue board.

b. **Rat Proofing.** Rat proofing consists of constructing buildings or of changing their construction to prevent the entrance of rats and the eliminate potential shelter for them within the structure of the building. It is obvious that rat proofing is of great importance in the prevention and control of rats. Rats often gnaw wooden doors and window frames to gain entrance into buildings; they can enlarge openings in masonry, particularly in mortar and brick of poor quality. Openings of more than 3/4-inch width, particularly those around pipes and wire conduits, should be closed. Conduits themselves should be limited, if possible, to sizes that will prevent rodent passage. Cracks around doors, gratings, windows, and other such openings, if less than 4 feet above the ground or accessible from edges, pipes, or wires, should be covered or filled. Doors should be self-closing and should fit tightly. Double walls and the space between walls should be blocked with fire stops; these stops, as well as the beams supporting floors, should be so constructed that they cannot be used by rats as runways. Wooden sills and doors and windows at ground level should be sheathed with metal to prevent gnawing. Sheet metal of at least 26-gauge, 1/4-inch and 1/2-inch hardware cloth, and cement are all suitable rat proofing materials, although rats have been known to gnaw fresh cement. Hardware cloth of 1/2-inch gauge will not stop the house mouse. Foundations should extend at least 3 feet below the surface of the ground and have a 1-foot offset extending outward from the building at the bottom to prevent burrowing (see figure 3-6). In rat proofing, it should be remembered that rats can jump 2 feet vertically, can dig 4 feet and occasionally even more to get under foundations, can climb rough walls or smooth pipes of up to 3-inch diameter, and can travel on telephone and light wires.

c. **Harborage Elimination.**

(1) Accumulations of trash and waste materials must be eliminated to prevent their use as rat shelters. Likewise, salvage lumber and similar materials should be stacked on platforms 18 inches above the ground and well away from the building walls. The removal of vegetation along canal banks and near buildings will aid in

eliminating rat shelters in these places. Limbs of trees overhanging a building should be trimmed to keep them not less than 4 feet from the structure, unless this interferes with camouflage.

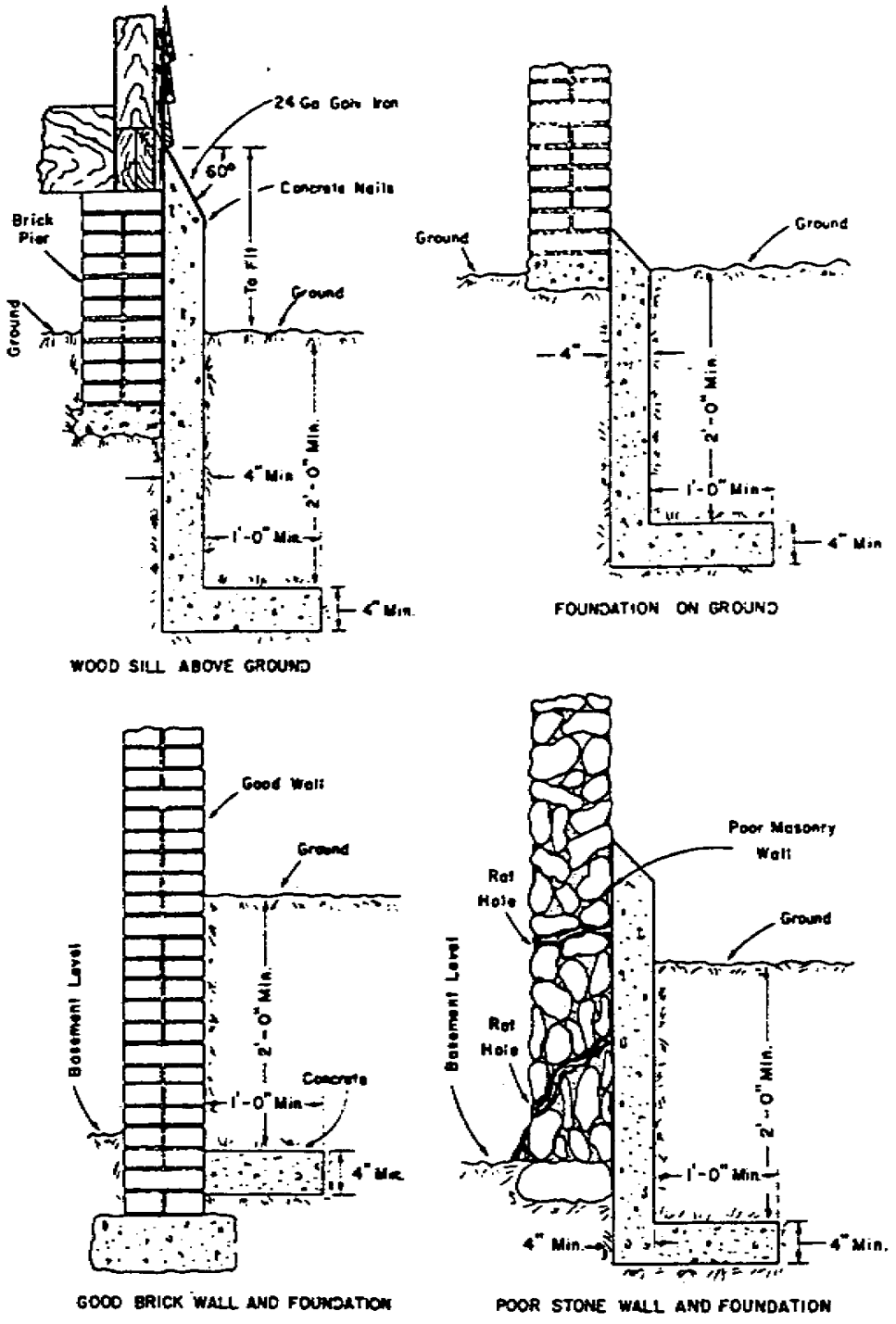


Figure 3-6. Curtain walls (for ratproofing).

(2) Harborages within buildings are of three types--structural, incidental, and temporary. Structural harborages include double walls, spaces between floors and ceilings, and boxed-in pipes and beams. The incidental types result from installation of "infestable" furniture, fixtures, and equipment, including shelves, counters, refrigerators, etc. Temporary shelters are those found in accumulation of rubbish, in piles of old lumber and rocks, and among masses of materials and supplies. During a control campaign, rat harborages should always be destroyed in order to prevent them from being used by new rodents that may enter the area later. This also will prevent such new occupants from becoming infested by ectoparasites that remain alive in the old shelters when their original hosts have been killed, an important consideration in disease control.

3-6. PHYSICAL CONTROL

The use of physical control involves the use of devices that change the habitat such that rodent behavior is affected or they are repelled. Recently, several manufacturers have developed and sold sonic and electromagnetic devices, claiming that they disrupt the rodents mating, feeding, and other habits or actually repel a rodent from the area. None of these items have been registered with the Environmental Protection Agency and furthermore, research has indicated that they are ineffective in repelling rodents. Because of these factors, the DOD does not recommend the purchase and use of these items for rodent control.

3-7. REGULATORY

a. **Laws and Regulations.** Local laws and standard operating procedures are used in the regulation of landfill operations and proper maintenance of sanitation in and around food handling establishments, quarters, and other government facilities. Various regulations govern standards of sanitation and procedures to be utilized at military installations and during combat operations.

b. **Retrograde Cargo.** Rodent control in and around port facilities may present some problems peculiar to that type of environment. The movement of ships from one country to another always poses a potential threat of communicable diseases spread by rodents and their ectoparasites. The Quarantine Service of the US Public Health Service is charged with the inspection against and eradication of vector pests brought to our shores by ships and aircraft. The Service maintains constant surveillance of incoming and outgoing traffic of all ports of entry. The principles of rodent control on shipboard and around waterfront areas are the same as mentioned previously. More emphasis should be placed on mechanical measures to prevent the movement of rodents to and from ships. Lighting all ramps and placing metal ratguards on all lines are two methods in worldwide use. Shipboard fumigation and intensive poisoning programs aboard ships and in waterfront areas are also used.

3-8. CHEMICAL CONTROL (POISONS)

a. **General.**

(1) The use of poisons (rodenticides) to kill rodents is an important part of any well-balanced rodent control program. It should be remembered, however, that programs depending solely on poisoning render limited results and are temporary since rodent populations quickly rebuild. Chemical control measures should be initiated in conjunction with rodent proofing and environmental sanitation programs. Rodent poisoning programs must be carefully planned and carefully executed. The fact that such a program is about to begin should be given the widest possible dissemination throughout the area in which the poison is to employed. This will help to prevent any possible accidental poisoning of humans or pets. The initial poisoning should provide complete coverage of the entire rodent-infested area. It may be useful to use pre-baiting (use of nonpoisoned bait) for up to 6 days prior to beginning the actual poisoning program in order to lessen the rodent's natural avoidance of strange objects and food. Pre-baiting would also aid in determining the rodents' food preference, and increase the chances of a successful control program.

(2) There are many rodenticides available; and their uses, effects, and hazards vary greatly. Safety requirements for the protection of humans, pets, livestock, poultry, and birds govern the selection of poisons and the methods in which they are used. Much of the poison is required to be used outdoors and in other places where access to it cannot be absolutely controlled, so any highly toxic poisons which do not contain an vomiting agent should not be used except by trained and certified personnel. These are personnel who have been specially trained in the safe, effective, and economical use of pesticides, and who have received certification from the command entomologist. Always read the pesticide label of the rodenticide to be used.

(3) Chemicals used in military rodent control programs are both standard and nonstandard. A standard rodenticide is one of which has been assigned a national stock number and which is available through normal supply channels. A nonstandard item is one that must be justified for a specific purpose and purchased from nonmilitary sources. Figure 3-7 lists the standard rodenticides commonly used in military pest control operations.

STANDARD RODENTICIDES FOR USE IN MILITARY OPERATIONS

1. General Use. The following rodenticides are considered general use items and may be used safely by other then certified personnel (for example Field Sanitation Teams) if label directions are followed. Procurement approval is not required. Rodenticides to read as follows:

Pesticide	Stock Number
Rodenticide Bait, anticoagulant, 0.005 percent diphacinone	6840-00-089-4664
Rodenticide Bait, anticoagulant, 0.005 percent Brodifacoum (Talon-G)	6840-01-426-4808
Rodenticide Bait, anticoagulant, 0.005 percent bromadiolone (Maki)	6840-01-151-4884

2. Supervision Required. The following rodenticides must be applied by, or under the direction supervision of trained and certified personnel. Procurement approval is required. Rodenticides to read as follows:

Pesticide	Stock Number
Rodenticide Bait, 2 percent zinc phosphide (ZP Rodent Bait) **restricted**	6840-01-435-9320
Rodenticide, 10 percent zinc phosphide (ZP Tracking Powder) **restricted**	6840-01-435-9318

Figure 3-7. Standard rodenticides for use in military operations.

b. **Anticoagulants.** Anticoagulants are the rodenticides generally recommended for use by the military, civilian health departments, or the public. They are available through supply channels as well as commercially, and they are the ones with which the untrained individual is the least likely to experience difficulty. The anticoagulant poisons such as Warfarin, Brodifacoum, Bromadiolone or diphacinone kill in a manner radically different from the older, single-dose poisons. They must be ingested for several days before they become effective. This provides a definite safety factor for children or animals eating a single large portion of anticoagulant bait. These poisons cause internal hemorrhages, so the rodents literally "bleed to death." Even when weakened, rats apparently do not associate their loss of strength with their food supply. They return to feed on anticoagulant-treated baits again and again. The problem of bait shyness commonly associated with "one-shot" poisons is largely

overcome. Nonfatal doses of single-dose poisons that are painful are largely overcome. Nonfatal doses of single-dose poisons are painful, where as anticoagulants apparently cause no pain.

c. **Nonstandard Rodenticides.**

(1) Zinc phosphide is a poison, which is effective against Norway rats, roof rats, and house mice. It kills them by causing heart paralysis and gastrointestinal and liver damage. The offensive odor and unattractive color of zinc phosphide serve as safety factors, in that most well-fed domestic animals will not touch baits prepared with it. However, domestic rodents seem to like the taste and pungent odor of the phosphorus.

(2) Epibloc (alpha-chlorohydrin). Epibloc is a new rodenticide, a toxicant sterilant. It both kills rats when lethal doses are eaten and sterilizes adult male rats, which eat sublethal doses. Like all pesticides, epibloc must be used in strict adherence with label directions.

d. **Preparation of Baits.**

(1) Rodenticides should be mixed with non-decomposing bait materials according to the printed instructions on the label of the container. Solid and liquid baits lose their attractiveness or evaporate after exposure and must be checked frequently to ensure that the available supply remains attractive and plentiful and to determine if they are located in the right places. Mix bait only as directed. Using too much poison may give the bait a strong taste or odor; using too little will not kill and may result in "bait shyness." Excessive amounts of poison increase the danger to man and to domestic animals. A vomiting agent, usually tartar emetic, is mixed with zinc phosphide to protect other animals, even though acceptability of such baits is thereby reduced. Bats are among the few animals that are unable to vomit.

(2) Since the foods preferred by rodents vary with the species and the geographical locality, samples should be placed for one or two nights in places frequented by the animals to ascertain which food is accepted most readily. Test samples should be selected from the three classes of food and fruits and vegetables (melons, sweet potatoes, bananas). Because some rats take peanut butter readily, but refuse bacon, for instance, several materials of each class should be tried. A binder of molasses or of vegetable, mineral, or fish oil is often used in cereal or dry baits to hold poison and dry bait together, and to aid in mixing

(3) Anticoagulant water baits are made by mixing sodium or calcium salts of the coagulants in water. They are usually dispensed in bait stations similar to chicken watering fountains. These fountains are often used in dry attics, in warehouses in which all water sources can be restricted, and in some bait stations with adequate space for both liquid and dry baits. Adding sugar to water baits can attract more rodents.

(4) Anticoagulants come in many ready-to-use forms such as bait blocks, pellets, toss packs, and paraffin formulations. These formulations require in mixing or formulating and hence are timesaving devices.

(5) Baits formulated with grain products (for example, toss-it packs, ready-to-use) may be a source of stored products pest infestation. Toss-it packs should not be used where infestable subsistance items are stored because of possible stored products pests infestations.

(6) The following precautions must be observed when mixing baits:

(a) Clearly label poisons and mixing equipment. Do not use mixing equipment for other purposes. Lock up poisons and mixing equipment when not in use.

(b) Treat all poisons with respect. Avoid inhaling powders or getting poisons on hands, clothes, or utensils from which they may reach the mouth.

(c) Always mix poisons in a well-ventilated place, particularly when mixing dry ingredients.

(7) For second-generation anticoagulants such as Talon (Brodifacoum), Maki (Bromadiolone), and Epibloc (alpha-chlorhydrin) numerous small baits (5 to 15 grams) should be used at intervals of 7 days in places frequented by rodents. Baits should be utilized in tamper-proof bait boxes addressed in paragraph e. below.

e. **Bait Boxes.** Bait boxes should be tamper-proof (where children or curious people can't reach the baits) and protected from domestic animals. They should be weather-resistant, unbreakable and should be nailed into place or secured in places where people may move or tamper with them. Several commercial-type bait boxes are available which fulfill these requirements. All bait boxes should have 2-inch openings.

3-9. MAINTENANCE OF CONTINUITY IN THE PROGRAM

Maintenance of continuity in the rodent control program is of paramount importance. The following steps should be followed to ensure the complete eradication of rodents:

a. Resurvey regularly.

b. Continue environmental sanitation.

c. Routinely inspect and repair rodent proofing.

d. Exterminate rodents as required.

3-10. ADDITIONAL INFORMATION

Additional rodent biology and control information is available in Technical Guide (TG) Number 138, Commercial Rodent Control, January 1985, US Army Environmental Agency, Aberdeen Proving Ground, MD 21010-5422.

Continue with Exercises

EXERCISES, LESSON 3

INSTRUCTIONS: Answer the following exercises by marking the lettered response that **BEST** answers the exercise, by completing the incomplete statement, or by writing the answer in the space provided at the end of the exercise.

After you have completed all of these exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. What percent of rodent traps can be counted on to kill rodents?

   a. 10 percent.

   b. 15 percent.

   c. 25 percent.

   d. 30 percent.

2. How much anticoagulant bait should be used in each feeding station?

   a. At least 2 ounces.

   b. At least 4 ounces.

   c. At least 1 ounce.

   d. At least 3 ounces.

3. Match the following:

a. Pival.	(1) Used as a fumigant.
b. Aluminum Phosphide.	(2) An anticoagulant.
c. Zinc Phosphide.	(3) A single-dose rodenticide.

4. Rodent infestations can usually be traced to:

   a. Unsanitary conditions.

   b. Absence of chemical control programs.

   c. Inadequate rodent-proofing.

   d. Destruction caused by wars or natural disasters.

5. Harborages within buildings are of three types: _____,

   _____, and _____.

6. If a disease is suspected in a rodent population, what must be done before rodent extermination begins?

   a. Complete rodent proofing of buildings.

   b. Destruction of rodent nests and harborages.

   c. Fumigation of burrows.

   d. Ectoparasite control.

7. Which of the following rodenticides is recommended for general use?

   a. Zinc phosphide.

   b. Anticoagulant, universal concentrate.

   c. Aluminum phosphide.

   d. Rodenticide, Bait, Anticoagulant, 0.005 percent Brodifacoum.

8. Match the following:

a. Mechanical control _____.	(1) Can best be accomplished through the use of residual insecticides.
b. Cultural control _____.	(2) The most effective means of controlling rodents.
c. Chemical control _____.	(3) Renders limited results and is temporary.
	(4) Consists of constructing or changing buildings to prevent entry of rodents.
	(5) Normally reserved for small rodent infestations and low rat densities.

9. Rodenticides should be used in _____ bait boxes to prevent children, curious people, and domestic animals from reaching the bait.

10. For proper ratproofing, openings of more than _____ width should be closed.

    a. 1/2 inch.

    b. 3/4 inch.

    c. 1 inch.

    d. 2 inches.

11. Chemical control measures should be initiated in conjunction with

    _____ and environmental sanitation programs.

12. During mechanical control measures, a rat is caught in each trap on the first night. What does this indicate?

    a. An insufficient number of traps were used.

    b. The rodent infestation is extremely heavy.

    c. All the traps are in ideal locations.

    d. The correct bait is being used.

13. If there is evidence of a rat infestation at a sanitary landfill, the compacted earth cover should be _____ inches thick at the end of each operating day.

    a. 6.

    b. 12.

    c. 18.

    d. 24.

Check Your Answers on Next Page

SOLUTIONS TO EXERCISES, LESSON 3

1. a (para 3-5a)

2. b (para 3-8f)

3. a (2) (para 3-8c(2)(c))
   b (1) (para 3-8c (2))
   c (3) (para 3-8c(1))

4. a (para 3-4a)

5. Structural, incidental, temporary (para 3-5c(2))

6. d (para 3-2a)

7. d (para 3-8b)

8. a (5) (para 3-5a)
   b (2) (para 3-4)
   c (3) (para 3-8a(1))

9. Tamper-proof (para 3-8f)

10. b (para 3-5b)

11. Rodent proofing (para 3-8a(1))

12. a (para 3-5a(1))

13. b (para 3-4b)

End of Lesson 3